PB82-203985

Draft Environmental Impact Statement Hilton Head, South Carolina Wastewater Facilties Existing Environment Technical Reference Document. Volume I

(U.S.) Environmental Protection Agency
Atlanta, GA

Dec 81

U.S. Department of Commerce
National Technical Information Service
NTIS

50272-101

REPORT DOCUMENTATION PAGE

1. REPORT NO. EPA 904/9-81-091a

2.

3. Recipient's Accession No. PB82-203985

4. Title and Subtitle
Draft Environmental Impact Statement, Hilton Head, South Carolina Wastewater Facilties Existing Environment Technical Reference Document, Volume I,

5. Report Date December 1981

6.

7. Author(s)
EIS Preparation Section, Region IV

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
U.S. Environmental Protection Agency
345 Courtland Street
ATlanta, GA 30365

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address

13. Type of Report & Period Covered DRAFT

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

This Draft EIS addresses proposed wastewater facilities for Hilton Head Island, South Carolina. Numerous wastewater management alternatives have been evaluated with particular attention to water quality in the area's surface and groundwater resources and the impacts of projected population growth on the natural and human resources of Hilton Head Island and the surrounding area.

17. Document Analysis a. Descriptors

Draft EIS
Volume I
Technical Reference Document

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement

19. Security Class (This Report)

20. Security Class (This Page)

21. No. of Pages

22. Price

(See ANSI-Z39.18) See *Instructions on Reverse* **OPTIONAL FORM 272** (4-77)
(Formerly NTIS-35)
Department of Commerce

PB82-203985

United States
Environmental Protection
Agency

Region 4
345 Courtland Street, NE
Atlanta, GA 30365

EPA 904/9-81-091 a
December 1981

EPA

Environmental Impact Statement

Draft

Hilton Head, South Carolina Wastewater Facilities Existing Environment Technical Reference Document

Vol. I

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV -
ATLANTA

HILTON HEAD ISLAND ENVIRONMENTAL IMPACT STATEMENT

TECHNICAL REFERENCE DOCUMENT A ENVIRONMENTAL INVENTORY TASK REPORT

VOLUME 1
NATURAL ENVIRONMENT

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
CLAUDE TERRY AND ASSOCIATES, INC.

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SECTION I

INTRODUCTION

CHAPTER I

INTRODUCTION

PURPOSE OF THE REPORT

The first meeting with the EIS Review Committee was held on October 1, 1979, to present the Plan of Study and receive comments from the Committee members. Following that meeting an intensive inventory was conducted to compile all the available information that could have a bearing on the EIS. The information collected and reviewed includes personal interviews, published reports, letters, memos, file data, and other records compiled by federal, state, and local agencies, special interest groups, and concerned citizens.

The purpose of this report is to establish a setting for the natural and man-made environments around which the alternative wastewater management schemes can be developed and evaluated. This report summarizes the information pertaining to the EIS that has been compiled by the study team.

Additional background information concerning the EIS and a general description of the study area are presented in the following sections of this chapter. The remaining chapters in this Task Report describe the key aspects of the natural and man-made environment of the study area.

BACKGROUND

Hilton Head Island lies off the southeastern tip of South Carolina, about 30 miles northeast of Savannah, Georgia. Hilton Head is the largest ocean-front island between New York and Florida - about twelve miles long, up to five miles wide, and covering approximately forty-two square miles. The Atlantic Ocean borders the island to the east, Calibogue Sound to the south, and Port Royal Sound to the north. Skull Creek, which comprises a link of the Intracoastal Waterway, separates Hilton Head from the mainland. Broad Creek, a seven-mile tidal inlet which opens to Calibogue Sound, runs diagonally across the island. In 1956, the James F. Byrnes Bridge was opened to traffic between Hilton Head and the mainland, thus eliminating the need for the ferry used prior to that time.

Hilton Head Island is largely devoted to resort development. Over half of the island has been developed according to the "plantation" concept. These planned unit developments contain residential, recreational, and occasional neighborhood commercial land uses. The second type of development is resort-oriented but made up of land devoted to apartments and condominium complexes. A third type of development on the island is rural residential, found on lands owned by citizens who resided on the island before development was undertaken.

Nodes of commercial and office/institutional development which serve island residents and visitors are located along Highway 278 near Hilton Head Plantation, at Sea Pines Circle, at Forest Beach, and at the Pineland Mall. The Harbour Town shopping district is located within the gates of Sea Pines Plantation.

Wastewater collection and treatment for the island is principally provided by designated public service districts, which have been established by enabling state legislation. There are four service districts on the island, as follows:

- Sea Pines Public Service District
- Forest Beach Public Service District
- Broad Creek Public Service District
- Hilton Head No. 1 Public Service District

Each public service district operates its own wastewater treatment and disposal facilities, with the exception of the Forest Beach Public Service District. Wastewater is conveyed from Forest Beach to the Sea Pines Public Service District for treatment and disposal.

Hilton Head Plantation is served by treatment facilities owned and operated by the Hilton Head Plantation Utilities Corporation. Several small, privately-owned treatment facilities are located elsewhere on the island which provide service to isolated residential or resort areas. These include the Mariner's Cove plant, the Northside Trailer Park plant, and the Port Royal Inn plant which lies within the boundaries of the Hilton Head No. 1 Public Service District.

The principal method used to dispose of treated effluent is land disposal, by either spray irrigation onto golf courses or adjacent land, or by infiltration/percolation from holding ponds. A portion of the treated effluent from the Sea Pines - Forest Beach facility is discharged into Lawton Canal, because current wastewater flows exceed the spray irrigation demands of the nearby golf courses.

Future wastewater needs for the Hilton Head Island area were addressed by the Beaufort County 201 Facilities Plan, through the year 1995. The future population of the island, and resultant wastewater flows, were based upon OBERS Series E projections.

The 201 Facilities Plan evaluated various combinations of wastewater treatment facilities for Hilton Head. In addition to the continued treatment of wastewater by the individual public service districts, several more regional concepts which would involve a lesser number of treatment facilities were considered.

The recommended alternative called for the continued operation of the existing PSD treatment facilities. First, the Sea Pines - Forest Beach waste treatment plant would be retained to serve its present service area. The Broad Creek waste treatment plant would likewise remain in its present situation. Third, the Hilton Head Public Service District No. 1 waste treatment plant would be upgraded with the service area remaining the same. Finally, the Hilton Head Plantation wastewater treatment plant would be expanded to include discharges from the Hilton Head Plantation, Mariners Cove and the Northside Trailer Park treatment plant. The effluent from all of these waste treatment plants would be disposed of by spray irrigation, so as not to impact area shellfish waters.

The recommendation for the continued use of spray irrigation on area golf courses as a final disposal method was predicated upon an assessment of area golf course needs. However, as evidenced by existing conditions at the Sea Pines plant, future wastewater flows to be disposed of by spray irrigation may eventually exceed the maintenance needs of the area golf courses. Because of this, other disposal methods must be evaluated, as either an alternate or supplement to spray irrigation.

Because of the need to consider other disposal techniques and their potential impacts on area shellfish waters, EPA has determined the need to conduct an Environmental Impact Statement to evaluate the issues associated with wastewater treatment and disposal on the island. This Environmental Impact Statement is being done to comply with the National Environmental Policy Act. The purpose of this Act is to encourage all Federal agencies to direct their policies, plans and programs to protect and enhance environmental quality. To comply with the Act, Federal agencies in consultation with the public and other Federal, State, and local agencies will assess in detail the potential environmental impacts for all major

Federal actions significantly affecting the quality of the human environment.

The objectives of this EIS are:

a. To identify major issues to be addressed in the EIS.
b. To provide a factual basis for the evaluation of alternatives by the provision of all necessary background information.
c. To evaluate all reasonable alternatives for the provision of wastewater transmission, treatment, and disposal.
d. To inform the public of the environmental consequences of these alternatives.
e. To determine the most environmentally favorable and cost-effective alternative for meeting project objectives.
f. To identify all potential adverse impacts associated with the chosen alternative and evaluate measures capable of mitigating these impacts.

MAJOR ISSUES

The major issues that this EIS will address have been identified through an initial review of past studies, available data, and correspondence relative to the 201 and 208 Plans and through a series of on-site meetings held on May 22-23, 1979, to solicit the views of state and local agencies, interested groups, and concerned citizens. The public scoping meeting held on June 28, 1979, on Hilton Head Island served to provide additional input from the Hilton Head residents. The major issues which have been initially identified include:

1. A method of disposal for treated wastewater effluent that is adequate for year 2000 capacity and is compatible with the water quality standards designated by DHEC must be determined.

2. The potential capacity for spray irrigation of treated wastewater effluent on the island must be determined and the impacts resulting from this wastewater disposal alternative assessed.

3. The magnitude and causes of non-point source pollution on the island must be determined in order to properly evaluate disposal alternatives for treated wastewater effluent.

4. The extent and cause of septic tank failures on the island must be determined.

5. The disparity between OBERS Series E population projections and indicated trends from historical growth, platted property holdings, and developer's plans and the resulting disparity in future wastewater flow projections should be assessed as it impacts the need for wastewater treatment and disposal facilities.

6. The impacts from growth supported by the provision of wastewater facilities must be evaluated, and measures to minimize adverse effects from projected development investigated.

The Hilton Head Island EIS study plan that has been developed is structured to address these issues.

SECTION II

DESCRIPTION OF THE NATURAL ENVIRONMENT

CHAPTER II-A

CLIMATE

Hilton Head Island has a temperate climate, which is primarily influenced by its proximity to the Atlantic Ocean. Temperature extremes are uncommon, with the exception of the high heat and humidity sometimes experienced during the summer months. Precipitation is fairly well distributed throughout the year; the largest amounts of rainfall occur during June, July, August, and September.

TEMPERATURE

The average year-round temperature of Hilton Head is approximately 66°F. Maximum temperatures range from 95°F to 100°F during July and August; minimum temperatures sometimes dip below 30°F during December, January, and February. These conditions contribute to a long-growing season, with the average length of the freeze-free period being around 280 days.

Table II-A-1 shows the variation in average monthly temperatures for this period. They range from an average of about 52°F in December to almost 80°F in August.

PRECIPITATION

Precipitation is fairly well distributed throughout the year. The average annual rainfall for the period 1970 to 1978 was nearly 54 inches.

As presented in Table II-A-2, the largest amounts of rainfall occur during June, July, and August as a result of thunderstorm and shower activity. This period of heaviest rainfall coincides with the peak tourist months for Hilton Head.

The heavy rainfall during these months, when wastewater flows are highest due to tourism, lessens the amount of treated wastewater that can be spray irrigated onto golf courses and other spray areas.

TABLE II-A-1

AVERAGE MONTHLY AND ANNUAL TEMPERATURE
FOR
HILTON HEAD ISLAND, IN °F(1)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
January	42 4	50.0	56.5	49.2	61.8	54.1	46.3	40.0	43.8
February	48.6	51.0	50.7	48.9	53.7	56.2	55.5	47.2	43.5
March	57.9	53.7	58.0	61.4	62.7	57.3	62.6	61.2	54.5
April	66.8	63.4	64.2	63.1	63.8	63.5	64.3	65.8	66.5
May	71.5	70.1	69.9	72.0	73.7	74.2	70.1	72.4	72.2
June	77.8	78.5	74.8	78.2	75.6	78.1	74.9	80.8	77.7
July	-	79.8	80.1	80.7	78.5	78.4	81.0	81.4	80.9
August	80.5	78.9	79.9	79.2	78.7	80.6	77.5	80.0	80.7
September	-	77.4	76.5	77.7	75.8	76.2	74.6	78.7	76.8
October	-	71.2	68.1	69.3	64.1	69.0	61.4	64.8	66.6
November	55.4	58.2	57.3	61.6	56.8	59.0	51.6	61.4	64.0
December	53.2	58.5	55.8	50.9	-	51.1	49.3	51.3	53.9
Average	-	65.9	66.0	66.0	-	66.5	64.1	65.4	65.1

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(1) From U. S. Department of Commerce, National Oceanic and Atmospheric, Annual Climatological Summary

TABLE II-A-2

AVERAGE MONTHLY AND ANNUAL PRECIPITATION
FOR
HILTON HEAD ISLAND, IN INCHES(1)

	1970	1971	1972	1973	1974	1975	1976	1977	1978
January	3.72	3.97	4.30	3.13	0.53	5.47	1.98	3.06	3.83
February	2.83	3.03	5.64	4.85	2.14	4.72	1.12	1.90	2.61
March	8.13	3.36	3.21	5.10	3.28	2.97	3.83	3.66	2.86
April	2.03	4.21	0.38	3.43	1.91	4.76	4.68	0.65	2.97
May	5.62	3.53	5.88	2.02	4.75	6.01	5.60	2.94	2.68
June	0.24	2.80	7.10	10.04	7.58	8.10	2.84	0.84	5.96
July	2.59	5.82	3.14	3.46	5.75	17.25	4.05	6.17	11.90
August	11.47	16.26	13.47	9.90	13.00	3.48	7.21	8.75	6.50
September	1.99	1.80	0.76	8.52	8.11	5.08	7.78	3.28	6.10
October	5.77	8.07	0.30	1.21	0.66	0.86	6.53	1.38	1.08
November	0.24	5.20	5.08	0.76	0.94	1.69	4.98	1.74	1.66
December	3.25	4.54	1.89	4.25	2.05	2.31	6.10	7.20	3.84
Average	46.88	62.59	51.15	56.67	50.70	62.70	56.70	41.57	51.99

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(1) From U. S. Department of Commerce, National Oceanic and Atmospheric, Annual Climatological Summary

CHAPTER II-B

AIR QUALITY

In compliance with federal law, the South Carolina Department of Health and Environmental Control (DHEC) has established ambient air quality standards. These standards are shown in Table II-B-1. To enforce these standards, the Department has established air quality monitoring stations throughout the state. One of these stations is located on Hilton Head Island at Harbour Town.

Air quality data for the Harbour Town station are presented in Table II-B-2. As shown by the data, air quality on the island is well within DHEC standards.

TABLE II-B-1

AMBIENT AIR QUALITY STANDARDS OF SOUTH CAROLINA

POLLUTANT	MEASURING INTERVAL	MICROGRAM/M^3(1) (2)
Sulfur Dioxide	3 hours	1300(4)
	24 hours	365(4)
	annual	80
Suspended Particulates	24 hours	250
	annual G.M.(3)	60
Carbon Monoxide	1 hour	25000
	8 hours	10000
Photochemical Oxidant	1 hour	160
Non-methane Hydrocarbons	3 hours	160
Gaseous Fluorides (as HF)	12 hours	3.7
	24 hours	2.9
	1 week	1.6
	1 month	0.8
Oxides of Nitrogen	annual	100

---

(1) Arithmetic Average except in case of suspended particulates.
(2) At 25 C and 760 mm Hg.
(3) Geometric Mean.
(4) Not to be exceeded more than once per year.

TABLE II-B-2

AMBIENT AIR QUALITY FOR 1978
AS MEASURED AT HARBOUR TOWN(1)

	Particulates(2)	Sulfur Dioxide(2)	Nitrogen Dioxide(2)
No. of Readings	52	46	49
Highest Value	64.0	13.0	31.0
Second Highest	63.0	12.0	25.0
Lowest Value	11.0	2.5	2.5
Arithmetic Mean		4.6	11.2
Geometric Mean	30.781	3.674	9.095
Geo. Std. Deviat.	1.515	1.874	2.031
Air Quality Standards(3)	60.0	80.0	100.0

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(1) From 1978 Air Pollution Measurements of the South Carolina Air Quality Surveillance Network published by DHEC.
(2) In micrograms per cubic meter.
(3) Annual average.

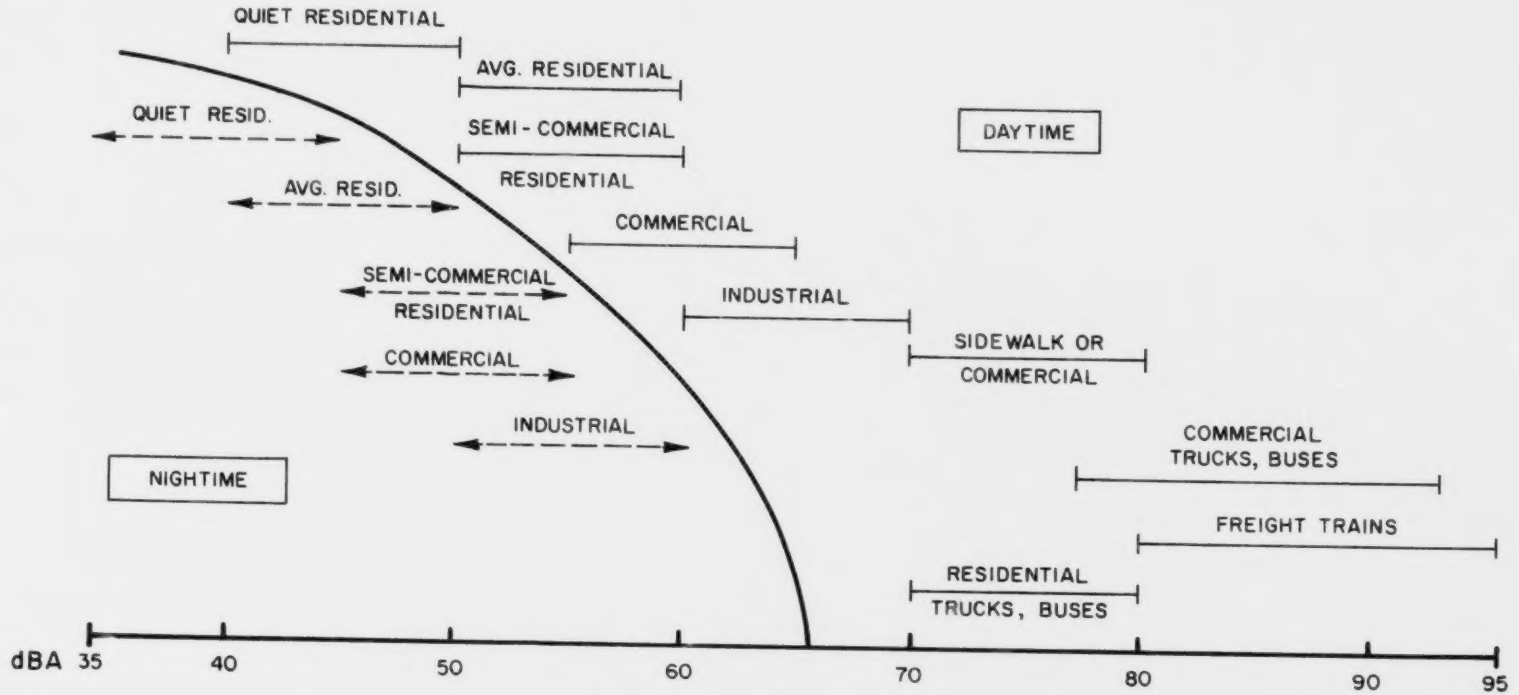
CHAPTER II-C

NOISE

The outdoor noise environment of the study area is relatively of the same magnitude and character at various locations throughout the island. Noise may vary with time of day at each location, being relatively quiet at night and somewhat noisier during peak periods.

Noise measurements are greatly influenced by the proximity of individual noise sources to the receptor and the time of day, and they do not adequately define the aggregate of noise sources in a region over an extended period of time. The overall noise environment of the island, however, can be adequately described by relating various land areas to their use. Figure II-C-1 presents typical noise levels for various land uses during daytime and nighttime hours. This figure is a summary of the results of numerous community noise surveys conducted throughout the United States (Shultz, 1972).

The outside noise environment of the island is predominated by areas of low to moderate noise levels, with higher noise levels existing along major transportation corridors. The following is a sample of the typical noise environments found on the island.



II C-1-a

SOURCE: PRIMER ON ENVIRONMENTAL IMPACT STATEMENTS,
RONALD BAHBARO AND FRANK L. CROSS, JR. 1973
WESTPORT, CONNECTICUT.

TYPICAL NOISE PATTERNS

FIGURE II-C-1

Area	Description
Plantation areas, rural communities	Quiet residential
Forest Beach residential area	Average residential
Harbour Town area	Semi-commercial, residential
Sea Pines Circle - Pope Avenue - Coligny Circle corridor	Commercial

A more specific approach to describing the noise environment of the island is to identify the primary sources of noise. Sources such as aircraft, highways, railroads, industrial plants, construction, and homeowner equipment have been identified as major sources of noise in the typical U. S. city. The most extensive and pervasive sources of noise in the outside environment result from transportation related activities. Within the study area the following noise generators influence the noise environment to some degree.

Noise Generator	Description
U. S. Route 278	Route 278 traverses the island and is its only major highway. Contiguous to the highway are a number of black communities and the private entrances to Hilton Head Plantation, Port Royal Plantation, Palmetto Dunes, and Shipyard Plantation. Strip commercial development is progressing along the length of Route 278.

Noise Generator (con't)	Description
Sea Pines Circle - Pope Avenue - Coligny Circle corridor	A major concentration of commercial activities is centered in this area. Noise levels are influenced by peak traffic periods. Only a few residential areas are affected; the nearest plantations are well buffered from the corridor.
Hilton Head Airport	The airport is located off of Highway 278, diagonally across from Pineland Mall. Local residents have voiced concern over the impacts of expanded airport operations. The Federal Aviation Administration has undertaken an airport noise abatement study in response to residents' concerns.

CHAPTER II-D

ODOR

No major odor producers have been identified within the boundaries of the Hilton Head EIS study area. However, some potential sources of localized odor do exist on the island, such as wastewater conveyance and treatment facilities and refuse collection boxes located in the non-plantation areas.

The conditions which predominate in wastewater force main systems frequently result in the production of hydrogen sulfide gas, which has a "rotten-egg" odor. Points of escape may be from pumping stations, from manholes in downstream gravity sewers, or at the treatment plants. Typically, sulfide odors are controlled through the injection of chlorine or hydrogen peroxide. Although pumping stations and force main systems are used extensively on Hilton Head to convey wastewater because of the flat topography, sulfide odors are not reported to be serious.

Offensive odors may also emanate from refuse collection boxes located on the island due to the decay of accumulated refuse in the boxes, spillage, and random dumping of putrescible refuse on the ground. In addition to the potential generation of odors, such unsanitary conditions can attract and support rodents and other vectors. The cluster of container boxes now on Marshland Road is an example of these conditions.

CHAPTER II-E

PHYSIOGRAPHY

The physiography of an area consists of its topographic, geologic, and soils characteristics. These factors are important in deciding the locations and design of sewage facilities and in the limitations they may place upon certain land uses. In particular, the analyses of these characteristics provide data on the suitability of certain locations for on-lot disposal of sewage or the potential of specific sites for spray irrigation of treated sewage effluent or sludge disposal. Consequently, the island's physiographic profile will provide an important input into development of facility alternatives.

TOPOGRAPHY

Hilton Head Island lies off the southeastern tip of South Carolina, about 30 miles northeast of Savannah, Georgia. Hilton Head is the largest ocean-front island between New York and Florida - about twelve miles long, up to five miles wide, and covering approximately forty-two square miles. The Atlantic Ocean borders the island to the east, Calibogue Sound to the south, and Port Royal Sound to the north. Skull Creek, which comprises a link of the Intracoastal Waterway, separates Hilton Head from the mainland. Broad Creek, a seven-mile tidal inlet which opens to Calibogue Sound, runs diagonally across the island.

Hilton Head Island lies within the Atlantic Coastal Plain province of the eastern United States and the Lower Coastal Plain segment of South Carolina. This region is mainly one of little-altered, primary topography, meaning that there are few, if any, major relief features. Elevations range from sea level to a high of 21 feet in Hilton Head Plantation. Generally, south of Broad Creek the average elevation is about 10 feet; whereas, north of Broad Creek elevations ranging from 15 feet to 20 feet are common.

Hilton Head Island is part of a chain of sea islands that parallel the mainland, extending from north of Charleston, South Carolina southward to central-southern Georgia. These islands have been interpreted as being part of the Pamlico Terrace which have been isolated from the mainland by a slight submergence. The salt marshes, sounds, and lagoons which separate the islands from the mainland are presumably courses of former streams and waterways that have been deepened by tidal scour accompanying and following submergence.

Hilton Head Island is classified as an erosion remnant island, considered a part of the eroded Pamlico Terrace which was not destroyed during a low stand of sea level because of being composed of resistant sediments. The erosion remnant islands are sand covered, irregular in shape, and lack dunal topography. Other erosion remnant islands in the area include St. Helena, Ladies, Port Royal, and Daufuskie.

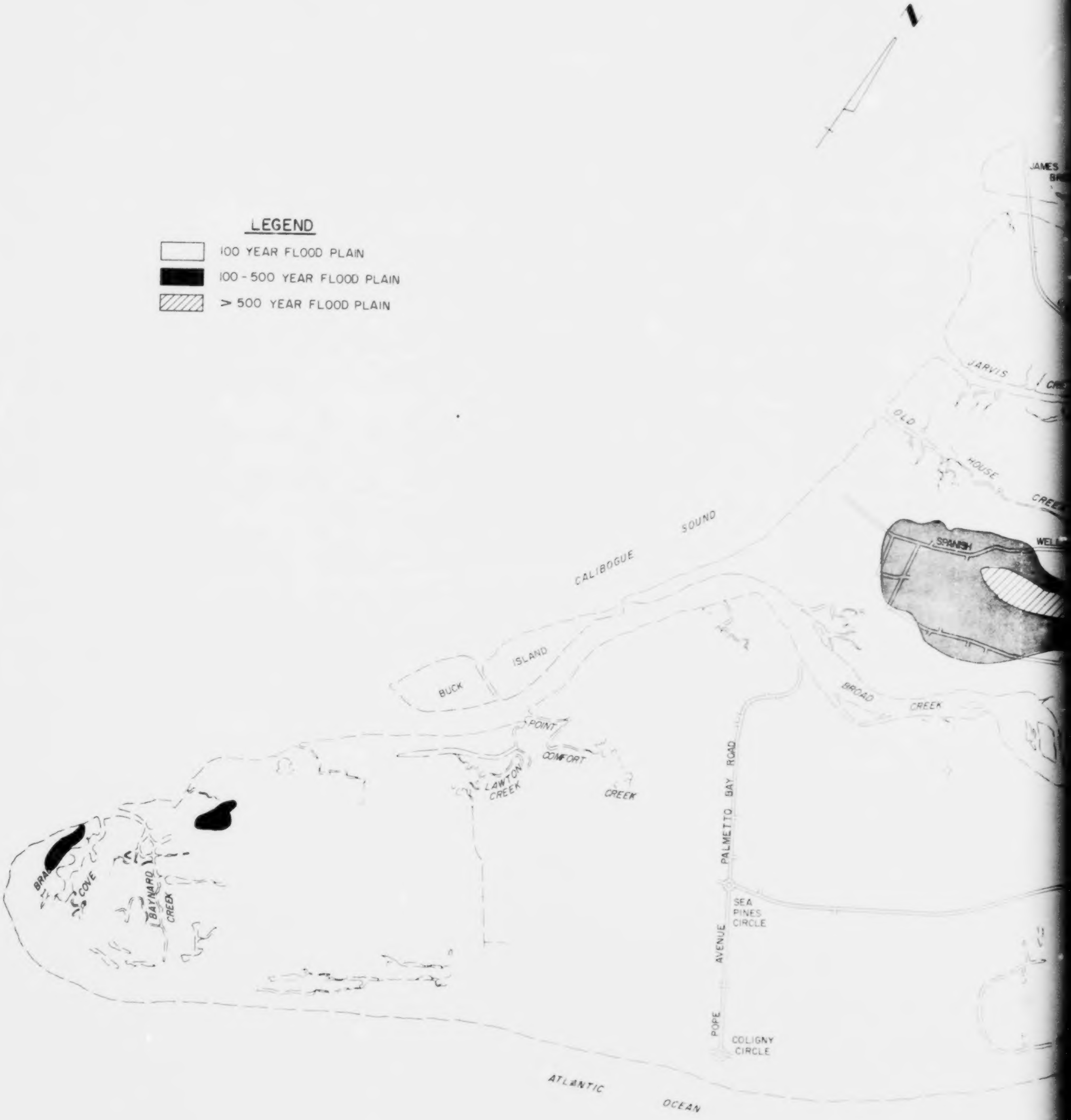
The low-lying nature of Hilton Head Island is graphically illustrated by the flood prone areas displayed in Plate II-E-1. The areas identified are the Flood Hazard Districts designated by the Federal Emergency Management Agency (FEMA) and the Federal Insurance Administration (FIA).

The ocean shoreline of Hilton Head Island has a relatively large curvature which contributes to a critical erosion condition. Generally, the shoreline south of Forest Beach is relatively stable; whereas, serious erosion problems exist along the shoreline from Forest Beach north to Folly Beach. It has been estimated that the island from Folly Creek to South Forest Beach is losing between 100,000 and 150,000 cubic yards of sand per year. Numerous proposals for short- and long-term solutions for dune erosion and storm tide protection are being reviewed, particularly for the North Forest Beach area.

GEOLOGY

General Geology and Stratigraphy. Poorly consolidated to unconsolidated sand, clay, marl, and limestone, ranging in age from Late Cretaceous to Holocene underlie the Lowcountry area.

The coastal plain wedge consists of seaward dipping and seaward thickening sedimentary units whose relative elevations reflect fluctuations in ocean levels over the past 120 million years, as well as regional warping of the continental margin. The rocks range in thickness from very thin at the Fall Line near Columbia to more than 3,500 feet along


LEGEND
▭ 100 YEAR FLOOD PLAIN
■ 100 - 500 YEAR FLOOD PLAIN
▨ > 500 YEAR FLOOD PLAIN
JAMES
JARVIS
OLD
HOUSE
CREEK
SPANISH
CALIBOGUE SOUND
BUCK ISLAND
BROAD CREEK
POINT
COMFORT
CREEK
LAWTON CREEK
COVE
BAYNARD CREEK
PALMETTO BAY ROAD
SEA PINES CIRCLE
POPE AVENUE
COLIGNY CIRCLE
ATLANTIC OCEAN

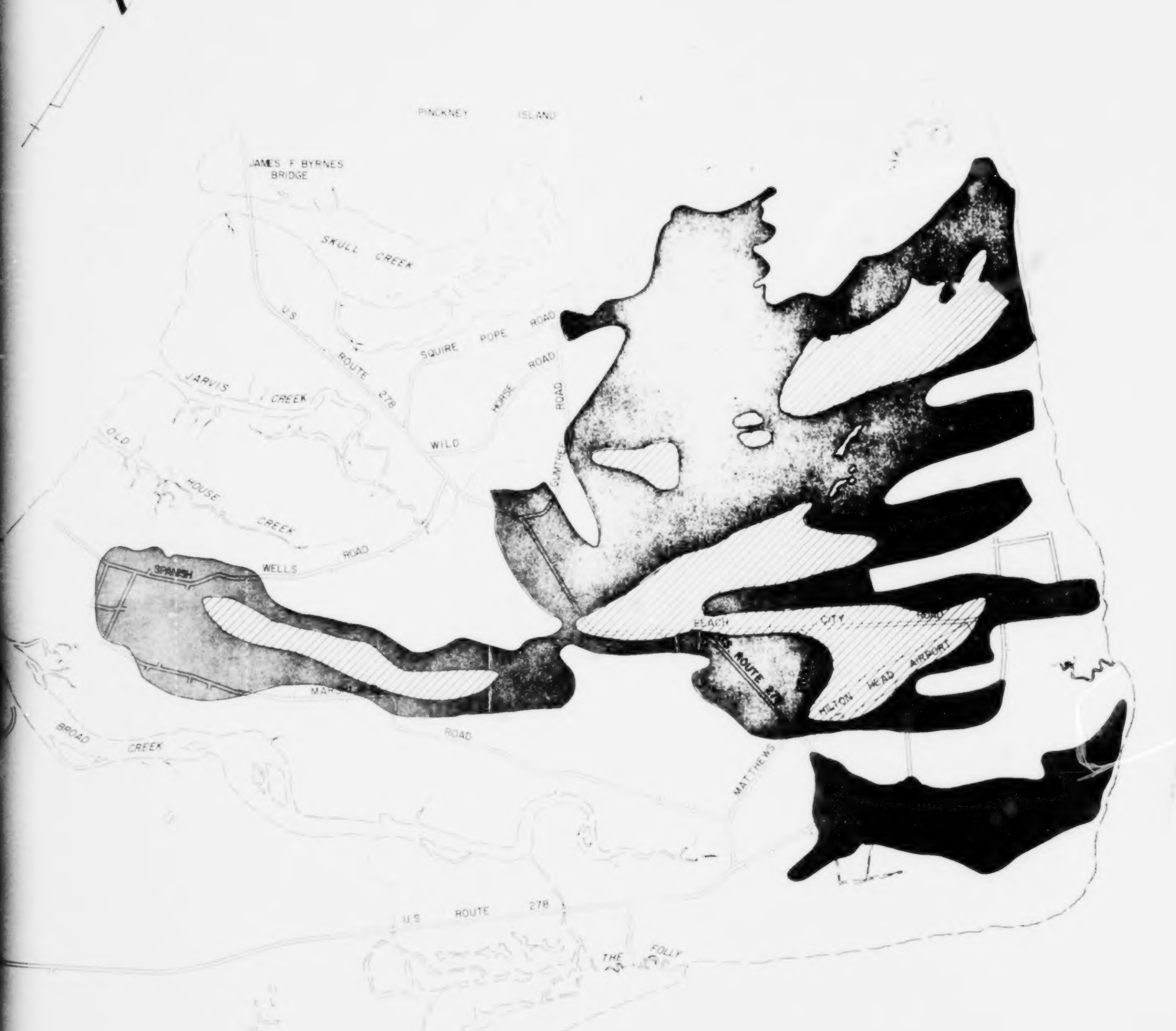

PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
US ROUTE 278
SQUIRE POPE ROAD
WILD HORSE ROAD
GUMTREE ROAD
JARVIS CREEK
OLD HOUSE CREEK
WELLS ROAD
SPANISH
MARSHLAND ROAD
BROAD CREEK
BEACH CITY ROAD
US ROUTE 278
HILTON HEAD AIRPORT
MATTHEWS
US ROUTE 278
THE FOLLY

PLATE II - E - 1

HILTON HEAD ISLAND
SOUTH CAROLINA

FLOOD PRONE AREAS

3000 0 3000 6000
SCALE IN FEET

US ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

II-F 3b

the coast near Beaufort and the southern part of Jasper County near Savannah, Georgia. These sedimentary rocks overlie a basement complex composed of granite, gneiss, schist, and diabase rocks of pre-Cretaceous age.

The oldest rocks in the Coastal Plain region were formed during Late Cretaceous time from fluvial, marginal marine, and marine deposits. The upper Cretaceous deposits are, in ascending order, the Middendorf Formation, the Black Creek Formation, and the Peedee Formation. Depths to the top of the Upper Cretaceous formations in selected wells in Beaufort County are given in Table II-E-1. The well numbers in the table are taken from the recent four-year cooperative study (Phase I) by the South Carolina Water Resources Commission (SCWRC) and the United States Geological Survey (USGS) of the ground-water resources in Beaufort, Colleton, Hampton, and Jasper Counties.

Descriptions of the Cretaceous System formation characteristics follow below.

1. Middendorf Formation. The lithology of the Middendorf Formation consists primarily of green, purple, and maroon clay; greenish-gray, micaceous silt; sandstone; and light-gray, fine- to coarse-grained sand. The thickness of the formation ranges from less than 800 feet in northern Colleton County to more than 1,200 feet in southern Beaufort County. The Middendorf Formation is equivalent to and locally known as

TABLE II-E-1

DEPTH TO THE TOP OF UPPER CRETACEOUS FORMATIONS IN SELECTED WELLS IN BEAUFORT COUNTY

Well	Location	Depth To Top Of Formation In Feet Below Mean Sea Level		
		Middendorf	Black Creek	Peedee
Bft 10	Parris Island	2,500	1,900	1,510
Bft 454	Hilton Head Island (Hilton Head Plantation)	2,650	2,030	1,660
Bft 457	Fripp Island	2,580	1,860	1,480

Reference: SCWRC, 1979, Report Number 9, " The Ground-Water Resources of Beaufort, Colleton, Hampton, and Jasper Counties, South Carolina.

the Tuscaloosa Formation.

2. Black Creek Formation. In the Beaufort area, the upper part of the Black Creek Formation consists of gray to black and greenish-gray, sandy clay, while the lower part consists of gray to white, phosphatic, glauconitic, fine sand interbedded with dark-gray and greenish red clay containing nodules of pyrite and marcasite. The thickness of the formation ranges from less than 400 feet in northern Colleton County to more than 600 feet in southern Beaufort County. Although this formation may be capable of supplying large quantities of fresh water in other parts of the state, it is unlikely that it will yield significant quantities of fresh water in Beaufort County due to high chloride concentrations.

3. Peedee Formation. The Peedee Formation is the youngest deposit of Late Cretaceous age in South Carolina. The dominant lithology of the formation in and around Beaufort County is interbedded, dark-gray clay; silty, micaceous, fine to medium sand; and streaks of hard, shelly, clayey limestone or calcareous, sandy siltstone. The thickness of this formation ranges from less than 300 feet in northern Colleton County to more than 500 feet in southern Beaufort County.

The Tertiary System consists, in ascending order, of the Black Mingo Formation of Paleocene and Early Eocene (Wilcox) age, the Santee Limestone of Middle and early Late Eocene (Claiborne and early Jackson) age, the Cooper Marl of latest Eocene (late Jackson) and Oligocene age, the Hawthorn Formation of Miocene age, and the Duplin Marl of Pliocene age. These Tertiary formations are the chief sources of ground-water supplies in southern South Carolina.

The depths to the top of the Black Mingo and Santee Limestone Formations in selected wells in Beaufort County are given in Table II-E-2. Descriptions of the Tertiary formation characteristics follow below.

1. Black Mingo Formation. In the Beaufort area, the Black Mingo Formation is divided into: (1) an upper part consisting of red to brown, sandy clay; partly indurated, fine, white to yellow sand; and a sugary sandstone containing shell fragments; and (2) a lower part that consists of gray to black, carbonaceous clay and shale showing conchoidal fractures.

The top of the Black Mingo ranges from about 400 feet below msl in northwestern Colleton County to more than 1,100 feet below msl in southern Beaufort County while the thickness ranges from less than 300 feet to more than 550 feet.

The Black Mingo aquifer is a source of moderate quantities of good quality water in the areas north of Beaufort County; however, in Beaufort County the Black Mingo Formation is unlikely to yield large quantities of fresh water. The Black Mingo aquifer consists of phosphatic, fossiliferous limestone; of sandy limestone; and of calcareous sand.

TABLE II-E-2

DEPTH TO THE TOP OF TERTIARY FORMATIONS IN SELECTED WELLS IN BEAUFORT COUNTY

Well	Location	Depth To Top Of Formation In Feet Below Mean Sea Level	
		Black Mingo	Santee Limestone
Bft 10	Parris Island	950	280
Bft 454	Hilton Head Island (Hilton Head Plantation)	856	140
Bft 457	Fripp Island	840	---

Reference: SCWRC, 1979, Report Number 9, "The Ground-Water Resources of Beaufort, Colleton, Hampton, and Jasper Counties, South Carolina."

2. Santee Limestone Formation. In the Middle and Lower Coastal Plains of South Carolina, the fossiliferous, highly-calcareous Santee Limestone and the basal Warley Hill Marl Formations make up the entire Middle and most of the Upper Eocene section. Landward, the Santee Limestone grades into clastic sediments such as those of the McBean Formation and of the Barnwell Formation. Because the Warley Hill Marl, if present, is not easily distinguishable from the overlying Santee Limestone, the entire Middle (Claiborne age) and the lower Upper Eocene (early Jackson age) sections are generally referred to as the Santee Limestone.

In southern South Carolina, the Santee Limestone generally can be divided into a lower, middle, and upper unit based on geophysical logs, lithologic logs, and hydraulic properties. In Beaufort County, the lowermost unit is an indurated, siliceous, glauconitic, light-gray to creamy-yellow limestone and averages about 30 feet in thickness; the middle unit of the Santee Limestone consists of soft, sandy, clayey limestone and ranges in thickness from less than 200 feet to more than 600 feet; and the upper unit consists of white to light-gray, calcitized, abundantly fossiliferous, indurated limestone containing bryozoan and echinoid fragments and ranges in thickness from essentially zero to more than 200 feet.

In southeastern Beaufort County, the top of the Santee Limestone ranges from less than 100 feet to more than 200 feet below land surface. The total thickness of the formation in Beaufort County is about 900 feet.

The Santee Limestone is part of the principal artesian aquifer and furnishes much of the ground water used in the area. Except where saltwater contamination has taken place, the Santee Limestone is capable of yielding from 200 to more than 2,000 gallons per minute (gpm) per well of good quality water.

3. Cooper Marl Formation. The entire Oligocene and uppermost section of the Eocene (late Jackson) age is considered to be Cooper Marl. The Cooper Marl Formation sediments vary from a very-sandy, calcareous, slightly to moderately phosphatic clay to a silty, sandy, phosphatic, clayey limestone to a light-gray to white limestone.

The top of the Cooper Marl occurs at about 50 to 75 feet below msl in much of Beaufort County. The thickness of the formation ranges from zero to more than 200 feet throughout southern South Carolina.

In much of Beaufort County, the lower part of the Cooper Marl is considered to be part of the principal artesian aquifer and is considered capable of yielding medium to large amounts of good quality water.

4. Hawthorn Formation. The Hawthorn Formation of Miocene age generally consists of phosphatic, clayey sand to phosphatic, sandy clay; of sandy, dolomitic limestone; and of highly-phosphatic, dolomitic, sandy, clayey limestone. The lateral extent and thickness of the Hawthorn Formation is at present not fully known. The SCWRC indicates that the Hawthorn Formation is present throughout most of Jasper County, much of the lower part of Hampton County, and parts of the western half of Beaufort County. Scattered remnants may be present in the eastern half of Beaufort County on the flanks of the Beaufort Arch and in Colleton County near the Edisto and Combahee Rivers.

The upper and lower sections of the Hawthorn Formation act as confining beds. The middle section of the Hawthorn is a fairly persistent, sandy, dolomitic limestone (Hawthorn aquifer) and is a source of small to medium amounts (50 to 200 gpm) of fairly good quality water.

5. Post-Miocene Formations. The post-Miocene sediments in southern South Carolina are composed of scattered remnants of Duplin Marl (Pliocene age) and of undifferentiated Pleistocene and Holocene deposits of the Quaternary Period. Only a few small isolated exposures of Duplin Marl have been recognized in the area. Where present, the Duplin Marl consists of a buff, sandy, friable, shelly, slightly phosphatic marl.

Pleistocene deposits consist of brown, gray, and green clays interbedded with white to buff, subangular to angular, quartz sand. Shell beds composed primarily of oyster shells embedded in a matrix of dark-green to gray clay are common along the coast. The Pliocene to Holocene deposits range in thickness from less than 25 feet in Beaufort County to more than 100 feet in southwestern Jasper County.

The water-bearing characteristics of these Pliocene and Holocene deposits are not well known. Many shallow domestic wells obtain water of acceptable quality from these deposits, particularly in Jasper County where the deposits appear to be thickest. However, near the coast or saltwater estuaries, water from these deposits may be salty.

Structural Elements. The Cape Fear Arch is the most prominent structural feature of the central part of the Atlantic Coastal Plain. The general shape of the arch is a gentle warp with the axial plunge increasing sharply near the shoreline and gradually decreasing updip toward the Fall Line. The basement rocks dip at an average of 13 feet per mile along the axis of the Cape Fear Arch from the Fall Line to the coast. Geologists have dated the formation of the Cape Fear Arch and of consequent downwarping of the flanks at different times, ranging from Early Cretaceous to Early Miocene, indicating that uplift and erosion occurred during more than one stage.

The Southeast Georgia Embayment interrupts the long, uniform slope of the basement away from the south flank of the Cape Fear Arch. It extends southwesterly to the Peninsular Arch of Florida. According to Maher, this embayment is primarily a tectonically passive feature although it may have undergone some downwarping on the continental shelf where the sedimentary rocks exceed 10,000 feet in thickness.

Along the southeastern flank of the Southeast Georgia Embayment are two local minor structures called the Burton High or Beaufort Arch and the Ridgeland Trough. Relief associated with these structures apparently is of low magnitude surficially and affects only pre-early Miocene and younger sediments.

As a result of the Beaufort Arch, upper Tertiary rocks comprising part of the principal artesian aquifer system have been brought close to the surface (in some places less than 25 feet below land surface). In contrast, in the Ridgeland Trough area the confining beds thicken considerably and the top of the principal artesian aquifer system occurs at greater depths (in some places more than 200 feet below land surface).

SOILS

Soils are a significant factor in the location and design of sewage facilities and in the limitations that they may place upon certain land uses. The analysis of soil provides data on the suitability of certain locations for on-lot disposal of sewage or the potential of specific sites for spray irrigation of treated sewage effluent or sludge disposal.

Descriptions. The Soil Conservation Service (SCS) of the U. S. Department of Agriculture published the Soil Survey of Beaufort and Jasper Counties, South Carolina, in January 1980. This survey is based on major fieldwork by soils scientists conducted during the period 1965-1975.

Shown on Plate II-E-2 is a general soil map of the four soil complexes and associations that have been identified and interpreted on Hilton Head Island. These soil complexes and associations consist of one or more major soils and some minor soils. Individual soils in a complex or association are called soil series. The grouping of series of soils does not imply that their characteristics are necessarily identical since the soils may vary considerably in depth, amount of rock, drainage, texture, slope, and other characteristics; however, it does indicate a certain similarity among these characteristics.

A soil complex consists of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. A soil association is made up of soils that are geographically associated and are shown as one unit on the soil map because it is not practical to separate them. A soil association has considerable regularity in geographic pattern and in the kinds of soil that are a part of it.

Descriptions of the four map units shown on Plate II-E-2 follow:

1. Wando-Seabrook-Seewee Association - This association consists of excessively drained, moderately well drained, and somewhat poorly drained soils that are sandy throughout. The minor soils in this map unit are the somewhat poorly drained Ridgeland soils, the poorly drained Baratari soils, and the very poorly drained Polawana and Rosedhu soils. All of the soils in this unit, except the excessively drained Wando soils, have a seasonal high water table. This is a severe limitation for septic tank absorption fields.

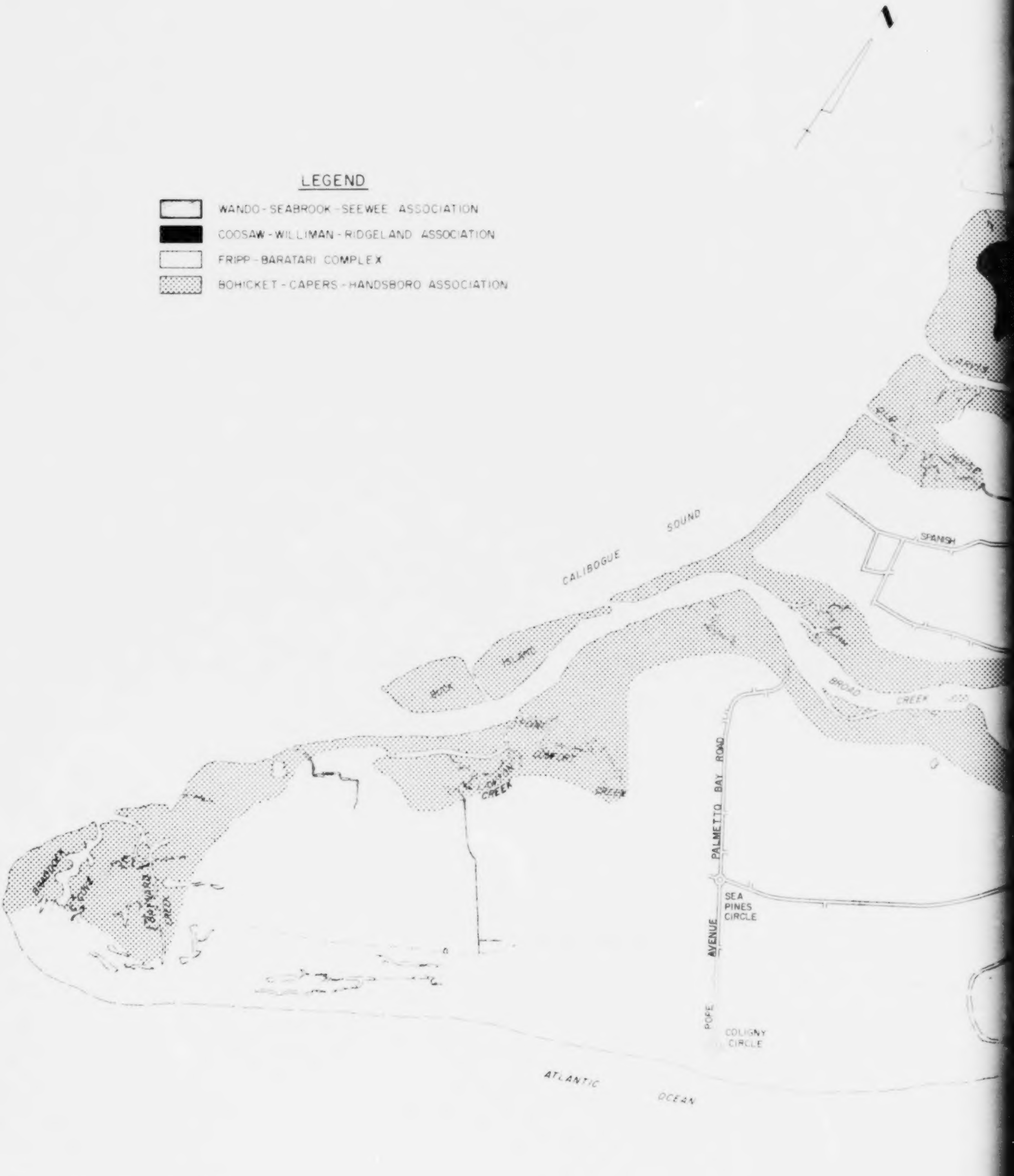
2. Coosaw-Williman-Ridgeland Association - This association consists of somewhat poorly drained and poorly drained soils that have a thick sandy surface layer and a loamy subsoil, and somewhat poorly drained soils that are sandy throughout. Most of these soils are bordered on one or more sides with tidal streams or marshes. All of these soils have a seasonal high water table. Among the minor soils in this map unit are the excessively drained Wando soils, the moderately well drained Seabrook soils, the somewhat poorly drained Murad soils, and the very poorly drained Deloss and Polawana soils. Wetness is the main limitation to use of these soils for farming, urban uses, and most other purposes.

3. Fripp-Baratari Complex - This complex consists of excessively drained (Fripp) and poorly drained (Baratari) soils that are sandy throughout. This complex consists of gently sloping to steep soils (Fripp) on narrow ridges and nearly level soils (Baratari) soils in narrow troughs. These soils formed in windblown marine sediment with the long axis of the ridges and troughs paralleling the coast line. Baratari soils have a seasonal high water table that ranges from a few inches above the surface to about one foot below it. Among the minor soils in this map unit are the somewhat poorly drained Seewee soils, the very poorly drained Polawana and Rosedhu soils, and the frequently flooded Capers soils. This map unit has low potential for nearly all major land uses; however, because of its proximity to the ocean, large areas have been intensively developed for residential and recreational uses.

4. Bohicket-Capers-Handsboro Association - This association consists of very poorly drained mineral and organic, nearly level soils that are flooded daily or occasionally by saltwater, and adjacent upstream areas that are flooded occasionally by freshwater. This map unit makes up about 35 percent of Beaufort County. Among the minor soils in this map unit are small islands of the excessively drained Wando soils, the moderately well drained Seabrook soils, the poorly drained Argent soils, and the very poorly drained Santee soils. Most of the soils in this map unit are in marsh grasses. The soils in this map unit are not suitable for cultivated crops, pasture, woodland, or urban uses.

The general soil map in Plate II-E-2 provides a broad perspective of the soils and landscapes on Hilton Head Island. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Detailed planning requires investigating the kind of soil at a specific site and uses a detailed soil map that shows delineations of phases of soil series. Soils that have a profile that is almost alike make up a soil series. Except for allowable differences in texture of the surface layer or the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile.


LEGEND
WANDO-SEABROOK-SEEWEE ASSOCIATION
COOSAW-WILLIMAN-RIDGELAND ASSOCIATION
FRIPP-BARATARI COMPLEX
BOHICKET-CAPERS-HANDSBORO ASSOCIATION
CALIBOGUE SOUND
SPANISH
BROAD CREEK
CREEK
PALMETTO BAY ROAD
SEA PINES CIRCLE
POPE AVENUE
COLIGNY CIRCLE
ATLANTIC OCEAN

SOURCE USDA, SOIL CONSERVATION SERVICE, "SOIL SURVEY OF BEAUFORT AND JASPER COUNTIES, SOUTH CAROLINA", JANUARY 1980

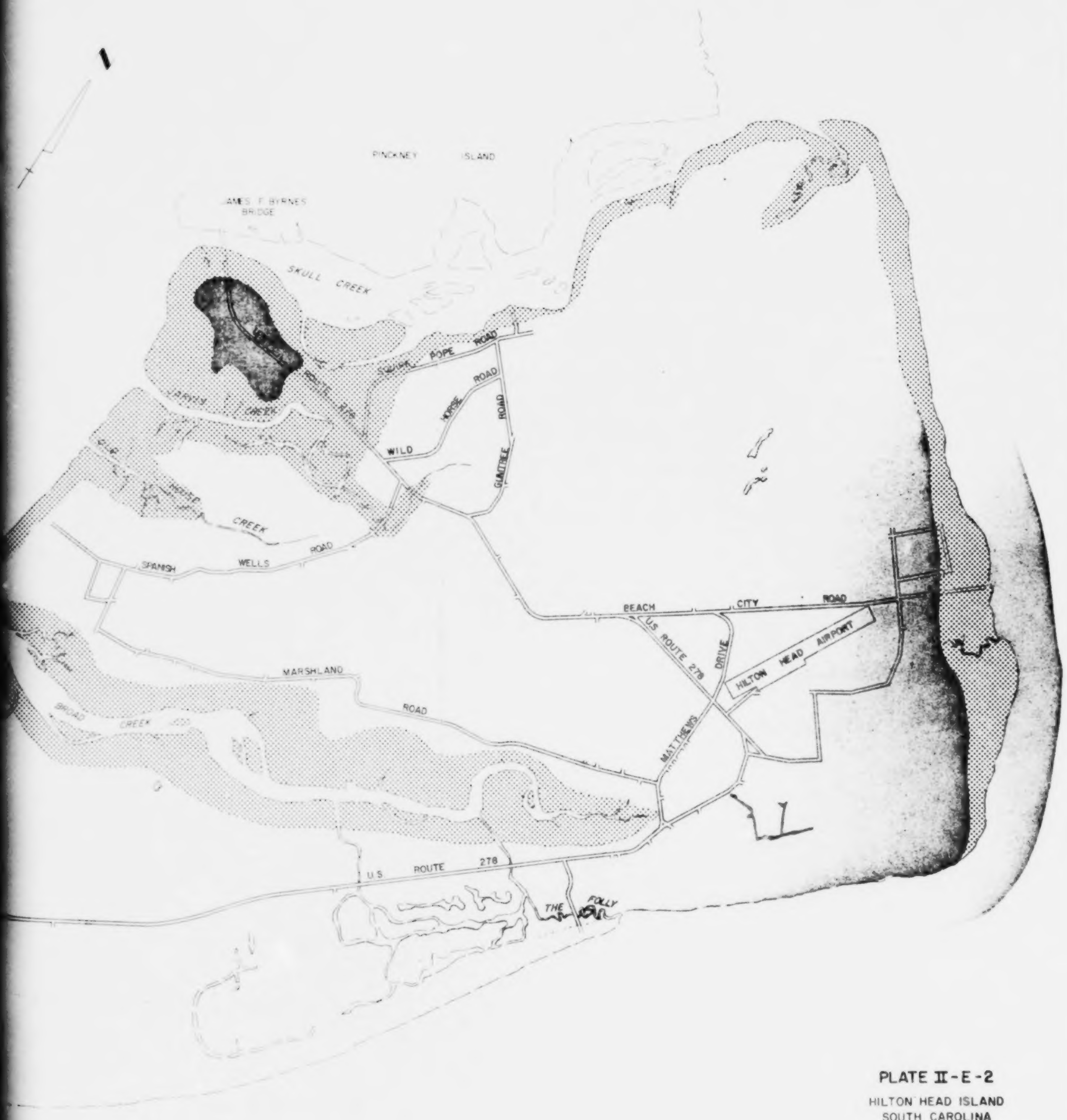

PINCKNEY ISLAND
JAMES F. BYRNES BRIDGE
SKULL CREEK
SQUIRE POPE ROAD
WILD HORSE ROAD
GUMTREE ROAD
ROUTE 278
JARVIS CREEK
CREEK
SPANISH WELLS ROAD
BEACH CITY ROAD
US ROUTE 278
MATTHEWS DRIVE
HILTON HEAD AIRPORT
MARSHLAND ROAD
BROAD CREEK
U.S. ROUTE 278
THE FOLLY

PLATE II-E-2

HILTON HEAD ISLAND
SOUTH CAROLINA

GENERAL SOILS MAP

3000 0 3000 6000

SCALE IN FEET

US ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

On Hilton Head Island fifteen individual soil series have been identified, interpreted, and mapped by the SCS. Because of the small scale of the base map and the intricate detail of the soil series delineation, detailed soils mapping is not provided in this report. The reader is referred to the Soil Survey of Beaufort and Jasper Counties, South Carolina, SCS, January, 1980. However, because the Wando fine sand series is the only one of the fifteen series on Hilton Head Island considered generally well-suited for on-lot sanitary disposal facilities, as will be discussed later in this chapter, it is mapped and shown on Plate III-J-2.

The soils on Hilton Head Island are generally poorly drained, moderately permeable sands, loamy fine sands, and sandy loams formed from thick sandy and loamy marine and fluvial sediments. The soils generally range from slightly acid to strongly acid. The following sections present the soil interpretations and characteristics.

1. Baratari Series - The Baratari series consists of deep poorly drained, moderately permeable sandy soils with a weakly cemented, organic stained layer within 25 inches of the surface. The surface layer is black, fine sand and the subsurface light gray fine sand. The soils are on level to nearly level terraces of the Lower Coastal Plain with slopes ranging from 0 to 2 percent. The Baratari series formed in sandy marine sediments. The water table is at depths of less than 10 inches of the soil surface for 1 to 6 months in most years and within depths of 60 inches most of the year. This strongly acidic to extremely acidic soil supports an abundant natural growth of woodland, consisting of pines, water oaks, blackgum, myrtle, and a thick undergrowth of sawpalmetto, gallberry, scrub oak, and maiden cane.

2. Bladen Series - The Bladen series is a member of the clayey, mixed, thermic family of Typic Albaquults. The Bladen series consists of poorly drained, slowly permeable soils on broad, nearly level fluvial or marine terraces that are waterlogged or flooded at some season. The soil formed in thick beds of acid clay or sandy clay containing some thin beds or lenses with coarser texture. Typically these soils have black, fine sandy loam surface layers about 7 inches thick and light brownish gray and grayish brown fine sandy loam subsurface layers. The subsoil is gray clay between depths of 14 to 41 inches. Below this to a depth of about 62 inches is dark gray clay. Slopes range from 0 to 2 percent. These soils have a water table within depths of 0 to 15 inches for 2 to 6 months each year. The soil ranges from strongly acid to extremely acid. Native vegetation consists of pines, sweetgum, blackgum, and water oaks.

3. Bohicket Series - The Bohicket series consists of very poorly drained, very slowly permeable sandy soils that formed in silty and clayey marine sediments. These soils are found on the broad level tidal flats bordering the sounds and the Atlantic Ocean and are flooded by sea water twice daily. They typically have a dark gray silty loam surface layer underlain by grayish clayey materials. Slopes are less than 1 percent. The soil ranges from slightly acid through moderately alkaline throughout and has high to very high salinity. The soils support a wetland wildlife habitat. Vegetation is smooth cord grass.

4. Capers Series - The Capers series is a member of the fine, mixed, nonacid, thermic family of Typic Sulfaquents. They consist of a very poorly drained, very poorly permeable (less than 0.2 inches per hour), soils on the broad level tidal flats and along the lower reaches of streams flowing into the tidal marshes. These soils have a very dark grayish brown silty clay surface layer about 16 inches thick and subsurface layers of black and very dark gray clay to a depth of about 60 inches. Slopes are less than 1 percent. Capers soils are flooded with brackish or salty water several times each month. The water table ranges from about 12 inches above the surface during spring tides to about 12 inches below the surface. These soils were formed in silty and clayey marine and stream sediments. These soils are used primarily as a natural habitat for wetland wildlife with the vegetation limited to salt-tolerant marshland plants.

5. Coosaw Series - The Coosaw series consists of deep, somewhat poorly drained, moderately permeable soils formed in sandy and loamy marine sediments. They are found on terraces of the Lower Coastal Plain. They typically have dark grayish brown loamy fine sand surface layers about 7 inches thick, underlain by light brownish gray loamy fine sands to 27 inches deep, brownish yellow fine sandy loams to 31 inches deep, yellowish brown sandy clay loams to 38 inches deep, and gray and light brownish gray sandy clay loams to about 77 inches deep. Slope gradients are dominantly less than 2 percent. Depth to the water table ranges from about 12 to 24 inches for 2 to 6 months during most years. The soils range from very strongly acidic to slightly acidic. Native vegetation is forest of loblolly, pines, few oaks, and a few blackgum.

6. Fripp Series - The Fripp series consists of deep, excessively drained, rapidly permeable (6 to 20 inches per hour) soils that are formed in thick sandy sediments adjoining beaches and waterways along the coast. The soils are in undulating to steep topography and occur as ridges and dunes along the coast. Typically these soils have grayish brown fine sand surface layers underlain by pale yellow and very pale brown fine sand that grades to white at lower depths. Slopes are commonly 5 to 15 percent but range from 2 to 30 percent. Flooding is rare for very brief periods due to very high tides caused by coastal storms. Most of this soil is used for recreation and beach cottages on Hilton Head Island.

7. Polawana Series - The Polawana series consists of very poorly drained, rapidly permeable (6 to 20 inches per hour) soils in depressions and drainageways. In a representative profile, the surface layer is loamy fine sand about 30 inches thick, with the upper 19 inches black and the lower 11 inches very dark gray in color. The underlying material to a depth of about 80 inches is dark grayish brown and light brownish gray fine sand. These soils formed in sandy marine sediments. Slopes are less than 2 percent. The water table is at depths less than 10 inches for about 4 months during most years. During the drier seasons the water table may recede to a depth of more than 40 inches. The organic matter content in the upper 50 inches ranges from 3 to 12 percent. The soil is very strongly acid through neutral. Natural vegetation consists of blackgum, sweetgum, tupelo gum, pines, and water oak.

8. Ridgeland Series - The Ridgeland series consists of somewhat poorly drained, moderately permeable, nearly level soils on the Lower Coastal Plain. In a representative profile the texture is fine sand throughout. The surface layer is very dark gray 8 inches thick. The next layer is weakly cemented, dark reddish brown, and 7 inches thick. The next layer is very pale 20 inches thick. Below this to a depth of about 84 inches is weakly cemented and dark reddish brown. Slopes range from 0 to 2 percent. Soil reaction ranges from slightly acid to extremely acid throughout. Water table is about 18 inches below surface for about 30 days most years and ranges from 18 to 50 inches most of the year.

9. Rosedhu Series - The Rosedhu series consists of very poorly drained, moderately to moderately rapidly permeable soils that formed in thick sandy Lower Coastal Plain sediments. The nearly level soils are in low areas. They are subject to flooding, and the water table is at or near the surface for about 8 months during most years. Slopes are generally less than 1 percent. Typically, the surface layer is black fine sand about 11 inches thick. Next is an illuvial humus layer of slightly brittle, fine sand about 14 inches thick. The upper 6 inches is dark reddish brown, and has dark brown mottles, and the lower 8 inches is dark brown and has dark reddish brown mottles. The next layer is brown fine sand and has dark brown mottles, and is about 28 inches thick. Below that is slightly brittle, dark reddish brown fine sand that has reddish brown, reddish gray, and dusky red mottles, and it is about 17 inches thick. The underlying material to a depth of 80 inches is grayish brown fine sand and has dark reddish brown and dark brown mottles. This soil is low in natural fertility and moderate in content of organic matter. It is extremely acid through strongly acid in about the upper 25 inches and very strongly acid through slightly acid below this depth.

10. Seabrook Series - The Seabrook series consists of moderately well drained, rapidly permeable, nearly level, sandy soils on the Lower Coastal Plain that formed in thick, sandy marine sediments. The surface layer is very dark grayish brown loamy fine sand about 9 inches thick underlain by about 33 inches of loamy fine sand that is mottled dark brown in the upper part and mottled brownish yellow in the lower part. Below this to a depth of 60 inches is gray loamy fine sand. Seabrook soils have numerous reddish-brown iron concretions throughout the profile. Slopes are less than 2 percent. Reaction of the soil ranges from very strongly acid to slightly acid. Natural vegetation consists of loblolly pine, live oak, and sweetgum.

11. Seewee Series - The Seewee series consists of sandy, somewhat poorly drained moderately rapidly permeable soils on level or nearly level broad ridges and flats along the Atlantic Coast. These soils formed in thick beds of sandy marine sediments. They typically have a black and dark grayish brown loamy fine sand surface layer 11 inches thick. The subsurface horizon is brown loamy fine sand 10 inches thick. The next layer is dark brown, weakly cemented fine sand 9 inches thick. The underlying material is grayish brown and light brownish gray fine sand to a depth of 65 inches. Slopes range from 0 to 2 percent. Reaction ranges from extremely acid in the surface layer through medium acid in the B and C horizons. The water table is less than 20 inches below the surface for more than 2 months during most years. Natural landuse is forest consisting of loblolly pine, longleaf pine, sweetgum, and water oak.

12. Wahee Series - The Wahee series consists of deep, somewhat poorly drained, slowly permeable soils that formed in clayey marine and fluvial sediments. Typically, the surface layer is very dark gray loam about 5 inches thick underlain by a 4-inch thick subsurface layer of light brownish gray loam. The subsoil is about 59 inches thick: the upper 4 inches is yellowish brown clay loam; the next 29 inches is gray clay; and the lower 26 inches is gray sandy clay loam. Slopes range from 0 to 4 percent. The water table is within 6 to 18 inches of the surface for four months during most years.

13. Wando Series - The Wando series consists of excessively drained, rapidly permeable loamy fine sands and fine sands that occur on nearly level to gently sloping uplands of the lower marine terraces. In a representative profile the surface layer is dark brown loamy fine sand 8 inches thick. The underlying material to a depth of 51 inches is brown to strong brown loamy fine sand. Below this is yellow fine sand to a depth of 72 inches. Slopes range from 0 to 6 percent. Concretions, averaging about 3 percent iron and dark reddish brown mottles or soft iron bodies occur in some pedons. The soil ranges from medium acid through neutral throughout. The water table is above 72 inches below surface for 1 to 2 months during most years. Most areas are in woodland or urban areas and some in cropland. Principal tree species are live oak, longleaf pine, dogwood, and holly.

14. Williman Series - The Williman series consists of deep, poorly drained, moderately permeable soils formed in loamy marine sediments. These soils are on broad, nearly level areas, depressions, and along drainageways of the Lower Coastal Plain. The surface layer is typically very dark gray loamy fine sand 5 inches thick. The subsurface layer is dark grayish brown to light brownish gray loamy fine sand. The subsoil is mottled, sandy clay loam to a depth of about 80 inches. The underlying material is mottled, fine sandy loam. Slopes range from 0 to 2 percent. The water table is within 12 inches of the soil surface for 1 to 2 months each year. The soil ranges from extremely acid to strongly acid in the A and B horizons. Forested areas on these soils are predominantly hardwoods with few to common pines.

15. Yonges Series - The Yonges series consists of deep, poorly drained, moderately slowly permeable soils that formed in thick loamy sediments on the Lower Coastal Plain. In a representative profile the surface layer is dark grayish brown loamy fine sand 10 inches thick. The subsurface layer is light brownish gray fine sandy loam 4 inches thick. The next layer is gray sandy clay loam 28 inches thick. Below this to a depth of 60 inches is gray fine sandy loam. These soils are nearly level with slopes less than 2 percent. The soils range from strongly acid to moderately alkaline throughout the profile. They are saturated with water late in the winter and early in the spring. The water table is within 10 inches of the surface for about 6 months during most years. Natural vegetation is forest consisting of sweetgum, loblolly pine, and oaks.

A more detailed description of the engineering, physical, and chemical properties of each of the soil series is given in Table II-E-3. The sources of these data are field survey, soil borings, and laboratory analyses of selected soil samples from typical profiles.

Soil Suitabilities. The primary factors affecting soil suitability for on-lot disposal systems are slope, flooding potential, depth to bedrock, depth to seasonal high water table, drainage, and permeability.

TABLE II-E-5
HILTON HEAD ISLAND SOIL CHARACTERISTICS[1]

Soil Series	Slope (Range-%)	Depth (inches)	Unified Soil Classification[2]	Permeability (inches/hr)	Hydrologic Soil Group[3]	Soil Reaction (pH)	Shrink-Swell Potential	Erodibility Factors[4,5]		Flooding Hazards			High Water Table[7]		Bedrock Depth (inches)	Drainage
								K	t	Frequency	Duration	Months	Depth[7] (ft)	Months		
Baratari	0 - 2	0-11 11-20 20-55	SP,SP-SM SP-SM SP,SP-SM	6.0-20 0.6-6.0 6.0-20	A/D	3.6-5.5 3.6-5.5 4.5-6.5	Very Low Very Low Very Low	0.10 0.10 0.10	5	None			0-1.0	Nov-Apr	>60	Poor
Bladen	0 - 2	0-14 0-14 14-41 41-62	SM CL,ML,CL-ML CL,CH CL,CH,SC	0.6-2.0 0.6-2.0 0.06-0.2 0.06-0.2	D	3.6-5.5 3.6-5.5 3.6-5.5 3.6-5.5	Low Low Moderate Moderate	0.10 0.10	5 5	None			0-1.0	Dec-May	>60	Poor
Bohicket	0 - 1	0-10 10-49	CH CH,MH	0.06-0.2 <0.06	D	6.1-8.4 6.1-8.4	High High	0.32 0.24	5	Frequent	Very Brief	Jan-Dec	+3-0	Jan-Dec	>60	Very Poor
Capers	0 - 1	0-16 16-60	MH MH	0.06-0.2 <0.06	D	6.6-7.8 6.6-7.8	Very High Very High	N[6]		Frequent	Very Long	Jan-Dec	+1-1.0	Jan-Dec	>60	Very Poor
Coosaw	0 - 2	0-27 0-27 27-31 31-77 77-85	SM,SP-SM SM SM,SM-SC SM,SC,SM-SC SM,SM-SC,SP-SM	6.0-20 6.0-20 2.0-6.0 0.6-2.0 2.0-6.0	D	3.5-6.0 4.5-6.0 4.5-6.0 4.5-5.5 4.5-5.5	Low Low Low Low Low	0.20 0.20 0.24 0.24 0.10	5 5	None			1.0-2.0	Dec-Mar	>60	Poor
Fripp	2 - [illegible]	0-5 5-80	SP,SP-SM SP,SP-SM	6.0-20 6.0-20	A	5.1-7.8 5.6-7.8	Low Low	0.17 0.17	5	Rare			>6.0		>60	Excessively Well Drained
Polawana	0 - 2	0-30 30-80	SM,SP-SM SM,SP-SM	6.0-20 6.0-20	D	4.5-7.3 4.5-7.3	Very Low Very Low	N		Frequent	Very Long	Dec-Mar	0-0.5	Dec-Mar	>60	Very Poor
Ridgeland	0 - 2	0-8 8-15 15-35 35-80	SP-SM,SM SP-SM,SP,SM SP-SM,SP,SM SP-SM,SP,SM	6.0-20 0.6-6.0 6.0-20 0.6-6.0	B	3.6-6.5 3.6-6.5 3.6-6.5 3.6-6.5	Low Low Low Low	0.17 0.15 0.17 0.15	5	Rare			1.5-2.5	Nov-Apr	>60	Poor
Rosedhu	0 - 2	0-11 11-25 25-53	SP,SP-SM SP-SM SP-SM,SP	6.0-20 0.6-6.0 6.0-20	B/D	3.6-5.5 3.6-5.5 4.5-6.5	Very Low Very Low Very Low	N		Common	Very Long	Dec-Mar	0-1.0	Nov-Jun	>60	Very Poor
Seabrook	0 - 2	0-9 9-60	SM,SP-SM SM,SP-SM	6.0-20 6.0-20	C	4.5-6.0 4.5-6.5	Low Low	0.10 0.10	5	None			2.5-4.0	Dec-Mar	>60	Moderately Well Drained
Seewee	0 - 2	0-21 21-30 30-65	SP-SM,SM SP,SP-SM,SM SP,SP-SM,SM	6.0-20 0.6-6.0 6.0-20	B	3.6-5.5 4.5-6.0 4.5-6.0	Very Low Very Low Very Low	N		Rare			1.0-2.5	Nov-Mar	>60	Poor
Wahee	[illegible] - 3	0-5 0-9 9-42 42-68	SM,SM-SC ML,CL-ML,CL CL,CH	0.6-2.0 0.2-2.0 0.06-0.2 0.2-0.6	D	3.5-6.0 4.5-5.5 4.5-5.5 4.5-5.5	Low Low Moderate Moderate	0.28 0.28 0.28 0.28	5 5	None to Common	Brief	Dec-Apr	0.5-1.5	Dec-Mar	>60	Poor
Wando	0 - 6	0-51 51-72	SP-SM,SM SP,SP-SM,SM	6.0-20 6.0-20	A	5.6-7.3 5.6-7.3	Very Low Very Low	0.10 0.10	5	None			>6.0		>60	Excessively Well Drained
Williman	0 - 2	0-26 26-80	SM SM-SC,CL-ML,SC,CL	2.0-6.0 0.6-2.0	D	3.6-5.5 3.6-5.5	Very Low Low	N		Rare			0-1.0	Dec-Apr	>60	Poor
Yonges	0 - 2	0-14 14-42 42-60	SM,ML CL-ML,CL,SC,SM,SC CL,ML,SC,SM	2.0-6.0 0.2-0.6 0.6-2.0	D	5.1-7.8 5.1-8.4 6.1-8.4	Low Low Low	0.15 0.17 0.20	5	None			0-1.0	Nov-Apr	>60	Poor

---

[1] Source: "Soil Survey of Beaufort and Jasper Counties, South Carolina", USDA, Soil Conservation Service, January 1980

[2] Unified Soil Classification System, as follows:
SP - Poorly graded sands, gravelly sands; little or no fines
SM - Silty sands, poorly graded sand-silt mixtures
SC - Clayey sands, poorly graded sand-clay mixtures
ML - Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
CL - Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
MH - Inorganic silts, micaceous or diatomaceous fine sands or silty soils, elastic silts
CH - Inorganic clays of high plasticity, fat clays

[3] Group A - Soils having a high infiltration rate (low runoff potential) when thoroughly wet.
Group B - Soils having a moderate infiltration rate when thoroughly wet.
Group C - Soils having a slow infiltration rate when thoroughly wet.
Group D - Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet.

[4] Soil Erodibility Factors (K) and Soil-Loss Tolerances (t) used in the Universal Soil Loss Equation, USDA Soil Conservation Service. The soil erodibility factor is a measure of the susceptibility of the soil to erosion by water. K values range from 0.10 to 0.64; the higher the value, the more erodible.

[5] The soil-loss tolerance factor (t) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality, expressed in tons of soil loss per acre per year. Entries are for the entire profile.

[6] N - Erodibility Factors not available or not estimated.

[7] High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. Plus sign (+) indicates above ground surface.

As shown in Table II-E-3, soils with high water tables and those with poor drainage or slow permeability are extensive throughout Hilton Head Island.

The Soil Conservation Service classifies soils or conditions as either "Slight", "Moderate", or "Severe". If the degree of soil limitation is expressed as "Slight", soils are generally favorable for the specified use and limitations are minor and easily overcome; if "Moderate", soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if "Severe", soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special design, or intensive maintenance is required.

A "Slight" classification means that the percolation rate is probably good; that the water table is deeper than 72 inches; that the depth to hard rock, bedrock, or other impervious material is more than 72 inches; that the slopes are slight; and that flooding does not occur. A "Slight" classification by SCS usually means that no particular problems will be encountered and that septic tanks and absorption fields should work properly when adequately sized, correctly installed, and maintained.

A "Moderate" classification means that the percolation rates may exceed 45 minutes per inch; it may mean that the water is at 48 inches rather than 72 inches; the depth to hard rock, bedrock, or other impervious material is 48 inches rather than 72 inches; that slopes have increased to 8-15 percent; or that while flooding is rare, it can occur. Thus it can be seen that "Moderate" can mean limitations on development that will be costly to overcome and result in the loss of some land for future development.

A "Severe" classification raises a red flag of caution, for it means that the percolation rates will exceed 60 minutes per inch over much of the area; that the water table is less than 48 inches from the surface; that the depth to rock is less thatn 48 inches; that slopes are greater than 15 percent; or that flooding occurs occasionally or frequently. Extensive engineering with careful planning is necessary to develop an area with such severely limiting conditions. More suitable areas must be found, for septic tanks and fields cannot be placed in the water table, or on slopes over 25 percent, or in rock, or where the soil does not absorb the water, or where flooding occurs.

The soil properties that determine suitabilities for spray irrigation of treated wastewater effluents, landfills, and sludge disposal are very nearly the same. The primary soil characteristics that limit the suitability of soils for these uses are: slope, depth to bedrock, depth to seasonal high water table, permeability, drainage, and flooding potential. For any of the above uses the depth to bedrock and high water table should be at least 5 feet. This is necessary to provide complete renovation of wastewaters and sludges prior to entering bedrock and water tables and permit adequate soil material for the construction and maintenance of landfill operations. A potential serious problem exists, particularly in the area north of Bread Creek, of contamination of private shallow wells into the Hawthorn aquifer and unnamed Pleistocene deposits used by some of the Black Community. For spray irrigation of effluents the permeability should range from 0.6 to 2.0 inches per hour. Soils must be well-drained for any of the uses but should not be excessively drained, particularly for landfills because of potential seepage problems. Flood prone soils are considered unsuitable for any type of waste disposal.

The suitabilities and limitations for sanitary facilities, water management, and building site development are presented for each soil series in Table II-E-4. It is evident that all soil series except Wando are classified as "Severe" with regard to suitability for septic tank absorption fields. The principle limitations are wetness, slow permeability, and flooding hazards.

TABLE II-E-4

HILTON HEAD ISLAND
DEGREE AND KIND OF SOIL LIMITATIONS AFFECTING SELECTED USES BY SOIL SERIES [1,2]

	Sanitary Facilities			Water Management					Building Site Development		
Soil Series	Septic Tank Absorption Fields	Sewage Lagoon Areas	Sanitary Landfill (Area Type)	Pond Reservoir Area	Embankments, Dikes, and Levees	Excavated Ponds (Aquifer-Fed)	Drainage	Irrigation	Shallow Excavations	Small Commercial Buildings	Local Roads and Streets
Baratari	Severe (WT, PF)	Severe (SP, WT)	Severe (SP, WT)	Severe (SP)	Severe (SP, PG, WT)	Severe (CC)	CC, WT	WT, DTY, FI	Severe (CC, WT)	Severe (WT)	Severe (WT)
Bladen	Severe (WT, PS)	Slight	Severe (WT)	Slight	Severe (WT)	Severe (SR)	PS	WT, PS	Severe (WT)	Severe (WT)	Severe (LS, WT)
Bohicket	Severe (FL, PND, PS)	Severe (FL, PND)	Severe (FL, PND)	Slight	Severe (HTP, PND, ES)	Severe (SR, SW)	PND, PS, FL	SICL: PND, PS SIC, C: PND, SI, PS	Severe (PND)	Severe (FL, PND, SS)	Severe (LS, PND, FL)
Capers	Severe (WT, FL)	Severe (FL, WT)	Severe (FL, WT)	Severe (EH)	Severe (LS, SS)	Severe (SR)	FL, PS	FL, PS	Severe (FL, WT)	Severe (FL, LS)	Severe (FL, LS)
Coosaw	Severe (WT)	Severe (SP, WT)	Severe (SP, WT)	Severe (SP)	Severe (PG, WT)	Severe (CC)	CC	WT, DTY, FI	Severe (CC, WT)	Severe (WT)	Moderate (WT)
Fripp	Severe (PF, SLP)	Severe (SP, FL, SLP)	Severe (SP, SLP)	Severe (SP, SLP)	Severe (SP, PG)	Severe (NW)	DTW	DTY, FI, SLP	Severe (CC, SLP)	Severe (FL, SLP)	Moderate to Severe (FL, SLP)
Polawana	Severe (FL, WT)	Severe (FL, SP, WT)	Severe (FL, SP, WT)	Severe (SP)	Severe (SP, PG, UF)	Slight	CC, FL, PO	FL, SP, WT	Severe (CC, FL, WT)	Severe (CR, FL, WT)	Severe (FL, WT)
Ridgeland	Severe (WT)	Severe (SP, WT)	Severe (SP, WT)	Severe (SP)	Severe (SP, PG)	Moderate (DTW, SR)	WT, CC	WT, FI, DTY	Severe (WT, CC)	Severe (WT, FL)	Moderate (WT)
Rosedhu	Severe (FL, WT)	Severe (FL, SP, WT)	Severe (FL, SP, WT)	Severe (SP)	Severe (SP, UF)	Slight	CC, WT, FL	NN	Severe (CC, FL, WT)	Severe (FL, WT)	Severe (FL, WT)
Seabrook	Severe (WT)	Severe (SP, WT)	Severe (SP, WT)	Severe (SP)	Severe (SP, PG)	Moderate (DTW)	Favorable	FI, WT	Severe (CC, WT)	Moderate (WT)	Moderate (WT)
Sewee	Severe (WT)	Severe (SP, WT)	Severe (WT, SP)	Severe (SP)	Severe (SP, UF, PG)	Moderate (DTW)	CC, WT	WT, SP, FI	Severe (CC, WT)	Severe (WT)	Moderate (WT)
Wahee	Severe (WT, PS, FL)	Severe (WT, FL)	Severe (WT, FL)	Slight	Severe (WT)	Severe (SR)	0-3% slope: PS, SL +3% slope: PS, FL, SL	L, SIL: WT, PS, FL SL, FSL, VFSL: WT, SB, PS	Severe (WT)	Severe (WT, FL)	Severe (LS, WT, FL)
Wando	Slight	Severe (SP)	Severe (SP)	Severe (SP)	Severe (SP, PG)	Severe (DTW)	NN	DTY, FI, SP	Severe (CC)	Slight to Moderate (SLP)	Slight
Williman	Severe (WT)	Severe (WT)	Severe (WT)	Moderate (SP)	Slight	Moderate (DTW)	Favorable	WT, FI	Severe (WT)	Severe (FL, WT, CR)	Severe (WT)
Yonges	Severe (WT, PS)	Severe (WT, SP)	Severe (WT)	Moderate (SP)	Severe (PG, WT)	Severe (SR)	Favorable	LFS: WT, FI, SB FSL: WT, SB	Severe (WT)	Severe (WT)	Severe (WT, LS)

---

[1] Source: "Soil Survey of Beaufort and Jasper Counties, South Carolina". USDA, Soil Conservation Service. January 1980.

[2] Abbreviations for Soil Limitations:

C - Clayey Materials
CC - Cutbanks Cave
CR - Corrosive
DTW - Deep to Water
DTY - Droughty
EH - Excess Humus
ES - Excess Salt
FI - Fast Intake
FL - Floods
FSL - Fine Sandy Loam
HTP - Hard to Pack

L - Loam
LFS - Loamy Fine Sand
LS - Low Strength
NN - Not Needed
NW - No Water
PF - Poor Filter
PG - Piping
PND - Ponding
PO - Poor Outlets
PS - Percolates slowly
SB - Soil Blowing

SI - Slow Intake
SIC - Silty Clay
SICL - Silty Clay Loam
SIL - Silty Loam
SL - Sandy Loam
SLP - Slope
SP - Seepage
SR - Slow Refill
SS - Shrink - Swell
UF - Unstable Fill
VFSL - Very Fine Sandy Loams
WT - Wetness

CHAPTER II-F

SURFACE WATER QUALITY

CLASSIFICATION OF SURFACE WATERS

In order to better understand existing state regulations regarding quality and classification of surface and shellfish waters, an historical review is required of the South Carolina Department of Health and Environmental Control (DHEC). The progentior of DHEC was the South Carolina State Board of Health which was established in the early 1900's. With the advent of increasing environmental awareness in the late 1960's and early 1970's, the South Carolina Pollution Control Authority was created in 1971 as an adjunct to, but independent of, the State Board of Health (much as the U. S. Environmental Protection Agency was an off-shoot of the U. S. Public Health Service in the same era). Under the South Carolina Pollution Control Act, the Authority classified State waters according to their use and established corresponding water quality standards in order to protect these uses.

In 1973 a centralized government reorganization took place combining the State Board of Health and the Pollution Control Authority into an umbrella agency known as the South Carolina Department of Health and Environmental Control (DHEC).

Presently, the Division of Biological Stream and Facility Monitoring, Bureau of Analytical and Biological Services monitors and evaluates surface waters for various levels of ambient water quality based upon stream classifications. The Enforcement and NPDES Administration Division of the Bureau of Wastewater acts upon these evaluations from an administrative capacity to determine what actions should be taken in regards to surface water quality. These two groups are primarily concerned with whether water quality violations come from point or non-point sources and what action can be taken to ameliorate the problem. The tidal waters of Hilton Head Island are classified as SA waters, "waters suitable for shellfishing for marketing purposes and any other usages", (Table II-F-1). Other surface water standards for tidal waters include SAA, SB and SC (Tables II-F-2, 3, and 4).

The actual opening and closing of shellfish waters is initiated by a separate and independent Division of DHEC, the Shellfish and Recreational Waters Division of the Bureau of Special Environmental Programs. The Division is authorized to promulgate regulations regarding shellfish sanitation and safety. Shellfish waters are classified as open or restricted and further subdivided as moderately and grossly polluted (Table II-F-5).

TABLE II-F-1

CLASS SA WATERS

Waters suitable for propagation, survival, and harvesting of shellfish for market purposes as designated by the Department of Health and Environmental Control. Suitable also for uses requiring water of lesser quality.

QUALITY STANDARDS FOR CLASS SA WATERS

ITEMS	SPECIFICATIONS
1. Garbage, cinders, ashes, oils, sludge or other refuse.	None.
2. Sewage of waste effluents.	None which are not effectively treated and disinfected.
3. Toxic wastes, deleterious substances, colored or other wastes.	None alone or in combination with other substances or wastes in sufficient amounts as to be injurious to edible fish or shellfish or the culture or propagation thereof, or which in any manner shall adversely affect the flavor, color, odor, or sanitary condition thereof or impair the waters for any other best usage as determined for the specific waters which are assigned to this class.
4. Dissolved oxygen.	Not less than 5 mg/l.
5. Organisms of coliform group.	Not to exceed a median coliform of 70/100 ml, nor shall more than 10% of the samples in a five (5) tube dilution test exceed a MPN of 230/100 ml; or current Department of Health and Environmental Control and U.S. Food and Drug Administration standards.
6. pH.	Shall not vary more than 3/10 of a pH unit above or below that of effluent-free waters in the same geological area having a similar total salinity, alkalinity and temperature.

Reference: DHEC. 1977. Water Classification Standard System for the State of South Carolina. South Carolina Department of Health and Environmental Control.

TABLE II-F-2

CLASS SAA WATERS

Waters suitable for uses that require the absence of pollution (South Carolina Pollution Control Act Section 1(7)) and/or waters which constitute an outstanding recreational or ecological resource. Suitable also for use requiring water of lesser quality.

QUALITY STANDARDS FOR CLASS SAA WATERS

ITEMS	SPECIFICATIONS
1. Garbage, cinders, ashes, oils, sludge, or other refuse.	None.
2. Sewage, treated wastes, thermal discharges, toxic wastes, deleterious substances, colored or other wastes.	None.
3. Dissolved oxygen.	Not less than 5 mg/l.
4. Organisms of coliform group.	Not to exceed a median coliform of 70/100 ml, nor shall more than 10% of the samples in a five (5) tube dilution test exceed a MPN of 230/100 ml; or current Department of Health and Environmental Control and U.S. Food and Drug Administration standards.
5. pH	Not outside of naturally occurring values.

Reference: DHEC. 1977. Water Classification Standard System for the State of South Carolina. South Carolina Department of Health and Environmental Control.

TABLE II-F-3

CLASS SB WATERS

Waters suitable for direct water contact and for survival and propagation of shellfishing except shellfishing for market purposes. Suitable also for uses requiring water of lesser quality.

QUALITY STANDARDS FOR CLASS SB WATERS

	ITEMS	SPECIFICATIONS
1.	Garbage, cinders, ashes, oils, sludge or other refuse.	None.
2.	Sewage or waste effluents.	None which are not effectively disinfected.
3.	Toxic wastes, deleterious substances, colored or other wastes.	None alone or in combination with other substances or wastes in sufficient amounts as to be injurious to edible fish or the culture or propagation thereof, or which in any manner shall adversely affect the flavor, color, odor, or sanitary condition thereof; to make the waters unsafe or unsuitable for bathing or impair the waters for any other best usage as determined for the specific waters which are assigned to this class.
4.	Dissolved oxygen.	Not less than 5 mg/l.
5.	Fecal coliform.	Not to exceed a geometric mean of 200/100 ml; nor shall more than 10% of the samples in any 30 day period exceed 400/100 ml.
6.	pH	Shall not vary more than one-half of a pH unit above or below that of effluent-free waters in the same geological area having a similar total salinity, alkalinity and temperature, but not lower than 6.75 or above 8.5.

Reference: DHEC. 1977. Water Classification Standard System for the State of South Carolina. South Carolina Department of Health and Environmental Control.

TABLE II-F-4

CLASS SC WATERS

Waters suitable for crabbing, commercial fishing and for the survival and propagation of marine fauna and flora.

QUALITY STANDARDS FOR CLASS SC WATERS

	ITEMS	SPECIFICATIONS
1.	Garbage, cinders, ashes, oils, sludge or other refuse.	None.
2.	Toxic wastes, oils, deleterious substances, colored or other wastes.	None alone or in combination with other substances or wastes in sufficient amounts as to be injurious to edible fish or the culture or propagation thereof, or which in any manner shall adversely affect the flavor, color, odor, or sanitary condition of fish or impair the waters for any other best usage as determined for the specific waters which are assigned to this class.
3.	Dissolved oxygen.	Not less than 4 mg/1.
4.	Fecal coliform.	Not to exceed a geometric mean of 1000/100 ml based on five consecutive samples during any 30 day period; nor exceed 2000/100 ml in more than 20% of the samples examined during such period (not applicable during or immediately following periods of rainfall).
5.	pH.	Shall not vary more than one pH unit above or below that of effluent-free waters in the same geological area having a similar total salinity, alkalinity and temperature but not lower than 6.75 or above 8.5.

Reference: DHEC. 1977. Water Classification Standard System for the State of South Carolina. South Carolina Department of Health and Environmental Control.

TABLE II-F-5

SOUTH CAROLINA STANDARDS FOR SHELLFISH AREAS

1. Approved Shellfish Areas. The median bacteriological content of water samples from areas determined by the sanitary survey to be most probably exposed to fecal contamination shall not exceed an MPN, (Most Probable Number), of 70 total coliform organisms per 100 ml of water sampled.

2. Moderately Polluted Restricted Areas. After making sanitary and bacteriological surveys, shellfish water may be declared a moderately polluted restricted area if:

   (1) The area is intermediate between approved and grossly polluted areas as regards exposure to and protection against fecal pollution.

   (2) The bacteriological survey discloses that the median bacteriological content of the water expressed in terms of the most probable number (M.P.N.) of coliform organisms per 100 ml. lies between 70 and 700, and if,

   (3) The sanitary survey shows that such contamination is probably of human origin.

3. Grossly Polluted Closed Areas. If the sanitary survey discloses that the area is either obviously subject to gross pollution by direct discharge of sewage and other wastes or, demonstrably exposed more or less continuously to even slight direct contamination with human fecal discharges from nearby sources ashore, or if an area usually of good quality is exposed to occasional direct and immediate contamination with human fecal discharges or if bacteriological examinations indicate that the degree of contamination is greater than that tolerated for moderately polluted areas, then such area may be declared to be a grossly polluted area from which the taking of shellfish shall not be permitted.

Reference: DHEC. 1976. Code of Laws of South Carolina, 1976, 44-1-150. Health and Environmental Control of R61-21 to R69-26. This information is taken from R61-47.

The Shellfish and Recreational Waters Division maintains its own set of water quality monitoring stations, and monitoring requirements (Table II-F-6), which are used to determine whether shellfish beds throughout the state should remain open or closed based upon violation of their established standards. These shellfish water quality stations are sampled once quarterly (Personal Communication, Luke Hause, DHEC). Where human fecal contamination is suspected, sampling is done on a monthly basis.

Additionally, the shellfish division periodically samples oyster shellstock at the growing areas or samples oysters at the point of shucking. Fecal coliform counts in oyster meats with an MPN value greater than or equal to 230/100ml should be interpreted as an indication of unfavorable conditions and should necessitate an investigation as well as improved control measures. An occasional MPN value of fecal coliforms as high as 2400 organisms/100ml will be tolerated. However if the above counts are exceeded in two or more consecutive samples of shellfish meats analyzed, corrective measures shall be taken.

A number of other regulations, which will not be addressed, affect the quality of shellfish for human consumption. Very briefly they include:

a) Hibernation and the collection of oysters from moderately polluted areas at water temperatures below 41° Fahrenheit.

TABLE II-F-6

SOUTH CAROLINA REQUIREMENTS FOR WATER QUALITY SAMPLING OF SHELLFISH WATERS

1. The sanitary survey shall disclose the likelihood of human fecal discharges reaching the shellfish area in dangerous concentrations or before sufficient time has elapsed to render such discharges innocuous. (1)

2. Water samples to be analyzed shall be collected throughout an area suspected of human fecal contamination during one or more active shellfish seasons, under various tidal stages, under varying weather conditions, and under unchanged pollutional source conditions as indicated by the sanitary survey.

3. Sanitary Surveys shall be made at least once every two years.

4. Bacteriological re-examination of an approved shellfish area shall be made when sanitary surveys indicate there may have been a significant increase in the quantity of sewage entering an area since the last bacteriological examinations.

5. Permanent sampling stations shall be located on a chart showing principal hydrographic and topographic data; where possible using USGS charts.

6. The spacing of sampling stations shall take into account the location of shellfish areas, the depth of water at low tide, and the proximity of probable sources of pollution.

7. In order to establish a line between an approved area and a moderately polluted area, sampling points shall not ordinarily be spaced at a greater distance than approximately 1000 feet in any direction. Where examinations are made to define the line between approved and restricted areas a recorded record of at least 15 samples per station in the critical area is necessary.

---

(1) Sanitary surveys involve visual observations to delineate potential sources of human contamination. Door to door surveys are often made in areas on septic tanks to pin point pollutional sources.

(2) Reference: DHEC. 1976. Code of Laws of South Carolina, 1976, 44-1-150. Health and Environmental Control of R-61-21 to R-69-26. This information is taken from R-61-47.

b) Relaying of shellfish from one approved growing area to another, or from a polluted area to an approved area.

c) Policing and posting of closed areas.

d) Depletion of closed areas.

e) Harvesting and handling of shellfish.

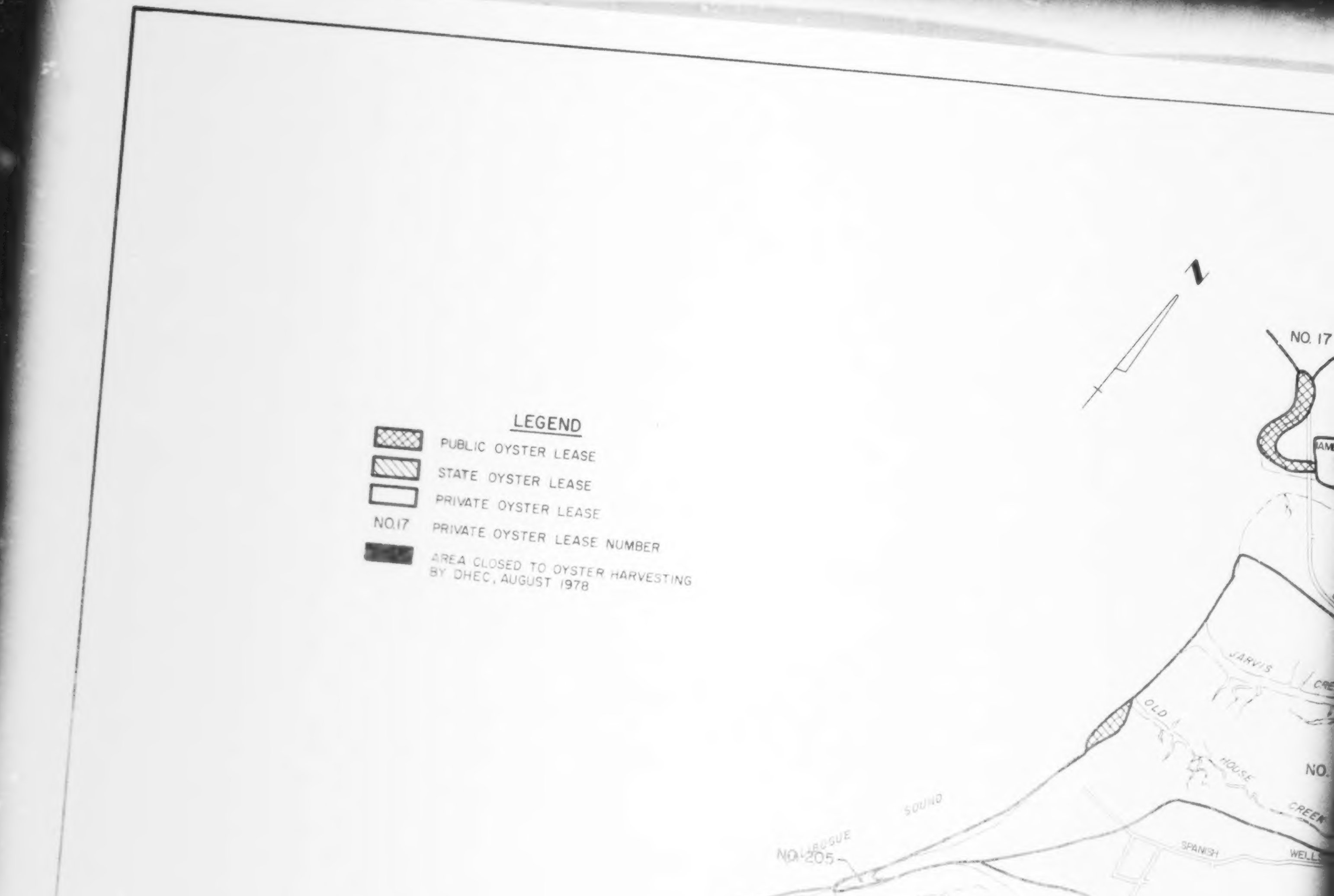
f) Preparation of shellfish for market.

In practice, it takes only one high total coliform count to close an area of shellfish beds to harvesting because of the danger from a public health point of view (Personal Communication Luke Hause, DHEC). If the source of contamination is obvious, the shellfish division will handle the matter internally. Shellfish beds will remain closed until water quality data statistically indicate that shellfish standards, primarily bacterial, are being met. When the source of contamination is not obvious, a special study will be requested from the Bureau of Analytical and Biological Services. Although the Shellfish and Recreational Waters Division, and the Bureau of Analytical Biological Services have different permanent sampling stations which are regularly monitored, they interact closely to identify areas that are in violation of water quality standards.

HISTORICAL PERSPECTIVE OF HILTON HEAD WATER QUALITY

Routine monitoring of the shellfish beds surrounding Hilton Head has been conducted since the mid-1960's. In 1974, quarterly monitoring of the shellfish beds began. If high total or fecal coliform counts were incurred, an investigation was undertaken with sampling at more frequent intervals, most often on a monthly basis.

During the early portion of the 1977-1978 oyster season the Shellfish and Recreational Waters Division of DHEC found unusally high fecal coliform counts in a routine investigation of oyster meats from the shell stock (raw unshucked oysters) of the Hilton Head Oyster Company operated by Buck Smith. His operation harvests from the Broad Creek Lease, (#12, Plate II-F-1). Initially, it was reported by the oyster picker that these oysters were being taken from the Calibogue Cay area. High oyster meat counts were again encountered upon sampling a second time in May 1978. Subsequent investigations and interviews with oyster pickers established that these oysters had been taken in Lawton Creek. Subsequent analyses of surface water samples from Lawton Creek in July 1978 revealed high total and fecal coliform counts. In August 1978 DHEC closed shellfish beds from "all waters and bottoms of Lawton Creek and Canal and Point Comfort Creek and the adjacent shore of Broad Creek running the length of Buck Island and Marsh" (Plate II-F-1). Prior to this time harvesting of oysters had only been prohibited by DHEC from "the waters and bottoms within a 1000 ft. radius of Palmetto Bay Marina, Harbour Town Marina and Baynard Cove Marina", (Plate II-F-1).


LEGEND
▩ PUBLIC OYSTER LEASE
▨ STATE OYSTER LEASE
☐ PRIVATE OYSTER LEASE
NO.17 PRIVATE OYSTER LEASE NUMBER
■ AREA CLOSED TO OYSTER HARVESTING BY DHEC, AUGUST 1978
N
NO. 17
JARVIS
CRE
OLD HOUSE CREEK
NO.
BOGUE SOUND
NO. 205
SPANISH WELL
BUCK ISLAND
NO. 12
BROAD CREEK
NO 3
NO. 12
BRADDOCK COVE
BAYNARD CREEK
NO. 12
PALMETTO BAY ROAD
SEA PINES CIRCLE
POPE AVENUE
COLIGNY CIRCLE
ATLANTIC OCEAN

SOURCES: 1. SOUTH CAROLINA COASTAL COUNCIL
2. SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL, BUREAU OF SPECIAL ENVIRONMENTAL PROGRAMS, SHELLFISH SECTION.

II-F-11a

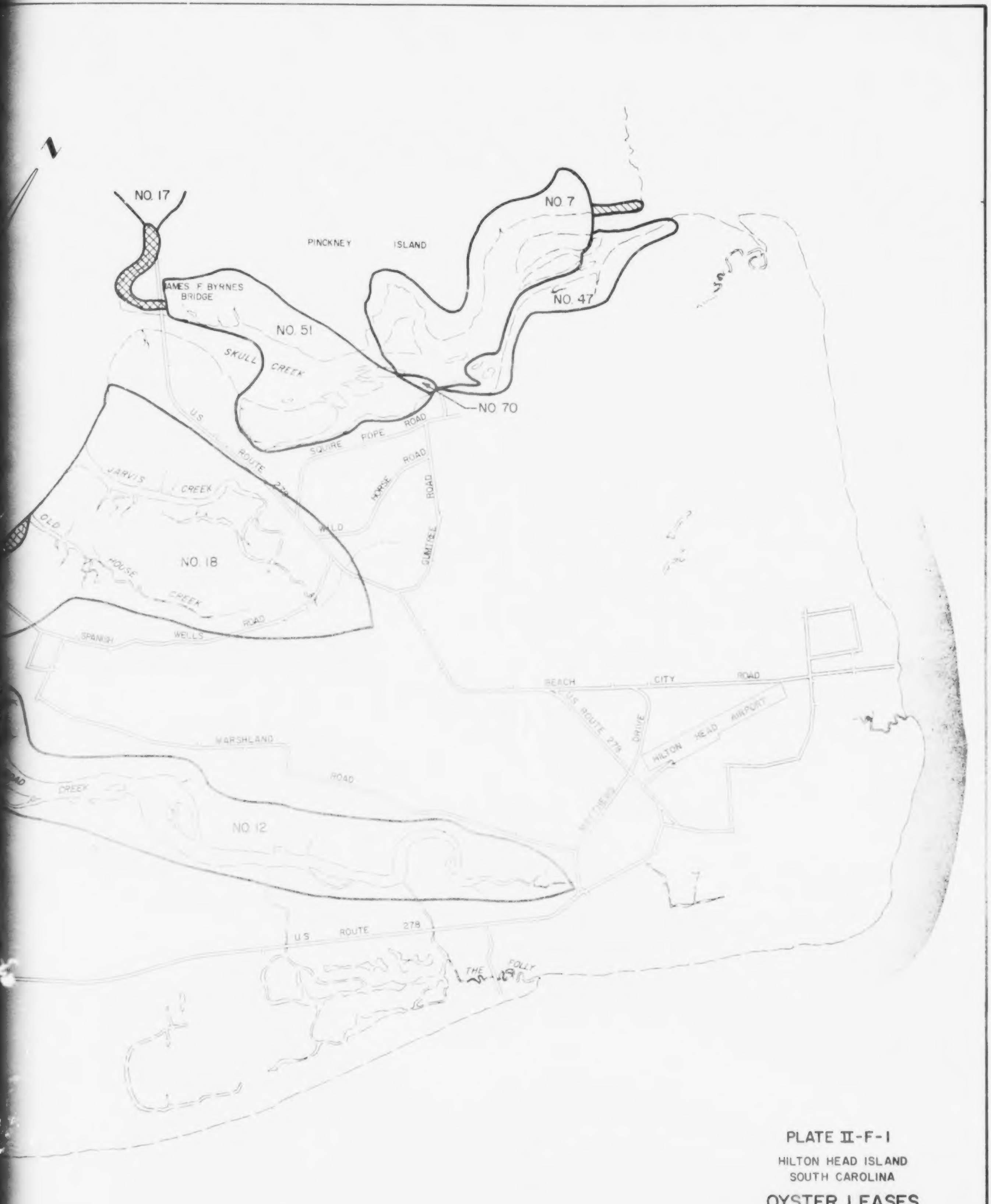

NO. 17
NO. 7
PINCKNEY ISLAND
JAMES F. BYRNES BRIDGE
NO. 51
SKULL CREEK
NO. 47
NO. 70
U.S. ROUTE 278
SQUIRE POPE ROAD
HORSE ROAD
GUMTREE ROAD
WILD
JARVIS CREEK
OLD HOUSE CREEK
NO. 18
SPANISH WELLS ROAD
BEACH CITY ROAD
US ROUTE 278
MATTHEWS DRIVE
HILTON HEAD AIRPORT
MARSHLAND ROAD
CREEK
NO. 12
U.S. ROUTE 278
THE FOLLY
3000
0
3000
6000

PLATE II-F-1

HILTON HEAD ISLAND
SOUTH CAROLINA

OYSTER LEASES

SCALE IN FEET

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

II-F-11b

These findings have since resulted in a number of special water quality studies initiated by DHEC and one study by the U. S. Public Health Service, Food and Drug Administration, Shellfish and Sanitation Branch. These studies are reviewed and pertinent information is presented in subsequent sections of this chapter. The on-going DHEC non-point source sampling program is discussed separately in the next chapter.

BASELINE WATER QUALITY DATA OF THE HILTON HEAD AREA

The purpose of this section is to review and evaluate historical water quality data from the Hilton Head area.

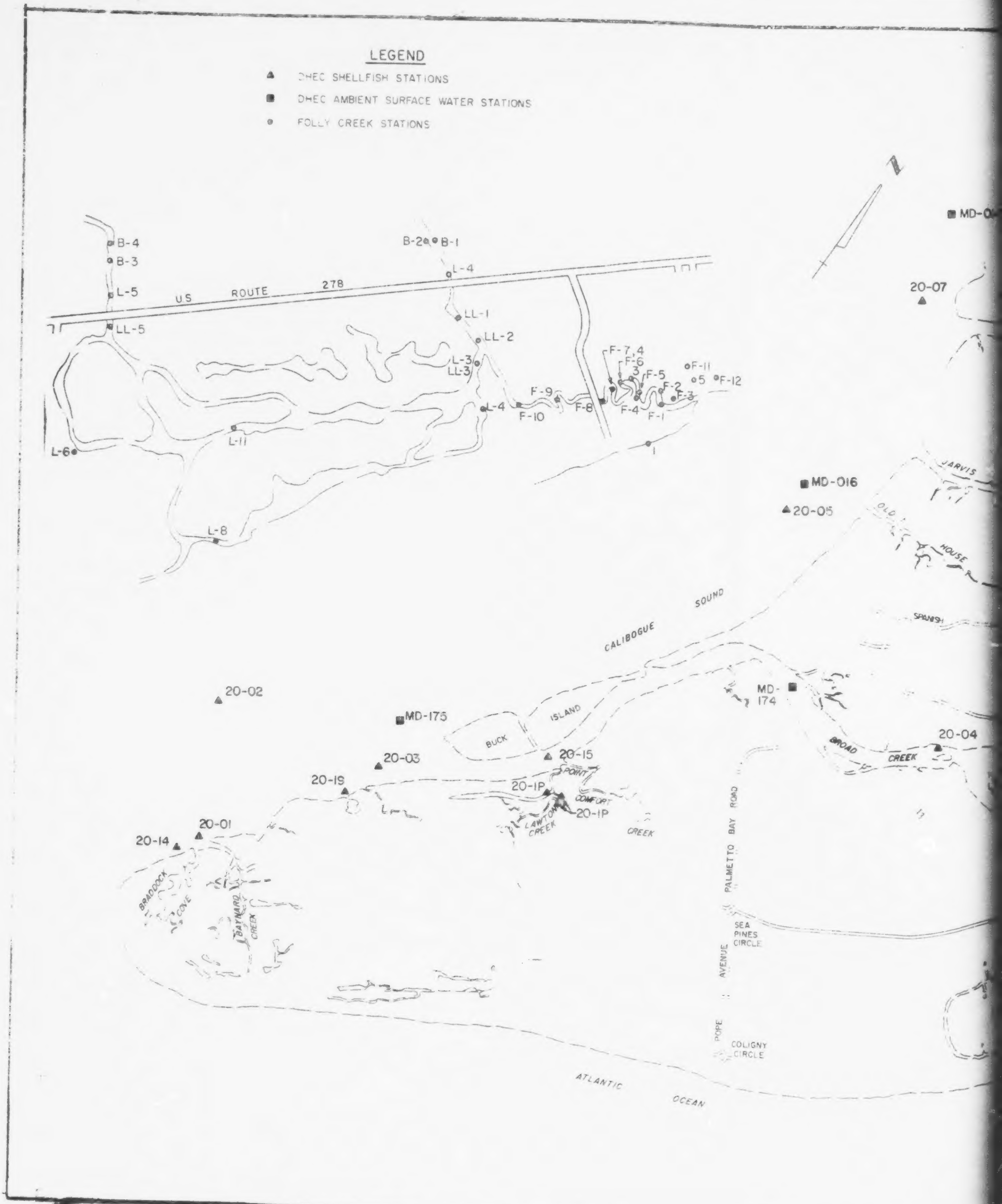
Water Quality Data From Folly Creek

The Broad Creek Public Service District desires to divert the water source of Folly Creek on Hilton Head Island from its present point of exchange with the Atlantic Ocean to an alternate source from Broad Creek through the Palmetto Dunes Lagoon System in order to combat erosion. Two environmental assessments have been performed to evaluate the effect of this possible change on the natural environment. One environmental assessment was conducted in August and September 1973, the other in April

1979. Although Folly Creek is not officially classified, all waters surrounding Hilton Head Island are classified as SA waters. Additionally the Palmetto Dunes Lagoon System drains into Broad Creek which is classified as SA waters and is an Approved Shellfish Area. As early as 1973 the waters at the Lagoon and at Folly Creek showed signs of high total coliforms that tended to exceed water quality standards of Class SA waters (Table II-F-7, Plate II-F-2). This continued to be the case in the April 1979 sampling runs for the same areas (Table II-F-8, Plate II-F-2). High total coliform counts were also encountered in the Broad Creek inlets into which the Palmetto Dunes Lagoon System periodically discharges via manually operated tide gates.

Although the fecal coliform concentrations (Table II-F-8) do not come under South Carolina State water quality standards, they appear to fall well within the U. S. Food and Drug Administration (FDA) criteria stating that median fecal coliform criteria shall not exceed 14 MPN/100ml with not more than 10 percent of the samples exceeding 43 MPN/100ml.

Unfortunately it is only possible to talk in qualitative terms concerning the above bacteriological data since insufficient sampling runs per station exist for statistical application to South Carolina water quality standards. The important observation that can be drawn from these data is the existence of high total coliform counts in the Palmetto Dunes


LEGEND
▲ DHEC SHELLFISH STATIONS
■ DHEC AMBIENT SURFACE WATER STATIONS
● FOLLY CREEK STATIONS
N
B-4
B-3
L-5
LL-5
B-2
B-1
L-4
US ROUTE 278
LL-1
LL-2
LL-3
L-3
L-4
F-9
F-10
F-8
F-7,4
F-6
3
F-5
F-2
F-4
F-1
F-3
F-11
5
F-12
1
L-11
L-6
L-8
MD-016
20-05
20-07
JARVIS
OLD HOUSE
SPANISH
CALIBOGUE SOUND
20-02
MD-175
BUCK ISLAND
MD-174
20-04
BROAD CREEK
20-03
20-15
20-19
20-1P
PORT COMFORT CREEK
20-1P
LAWTON CREEK
20-01
20-14
BRADDOCK COVE
BAYNARD CREEK
PALMETTO BAY ROAD
SEA PINES CIRCLE
POPE AVENUE
COLIGNY CIRCLE
ATLANTIC OCEAN

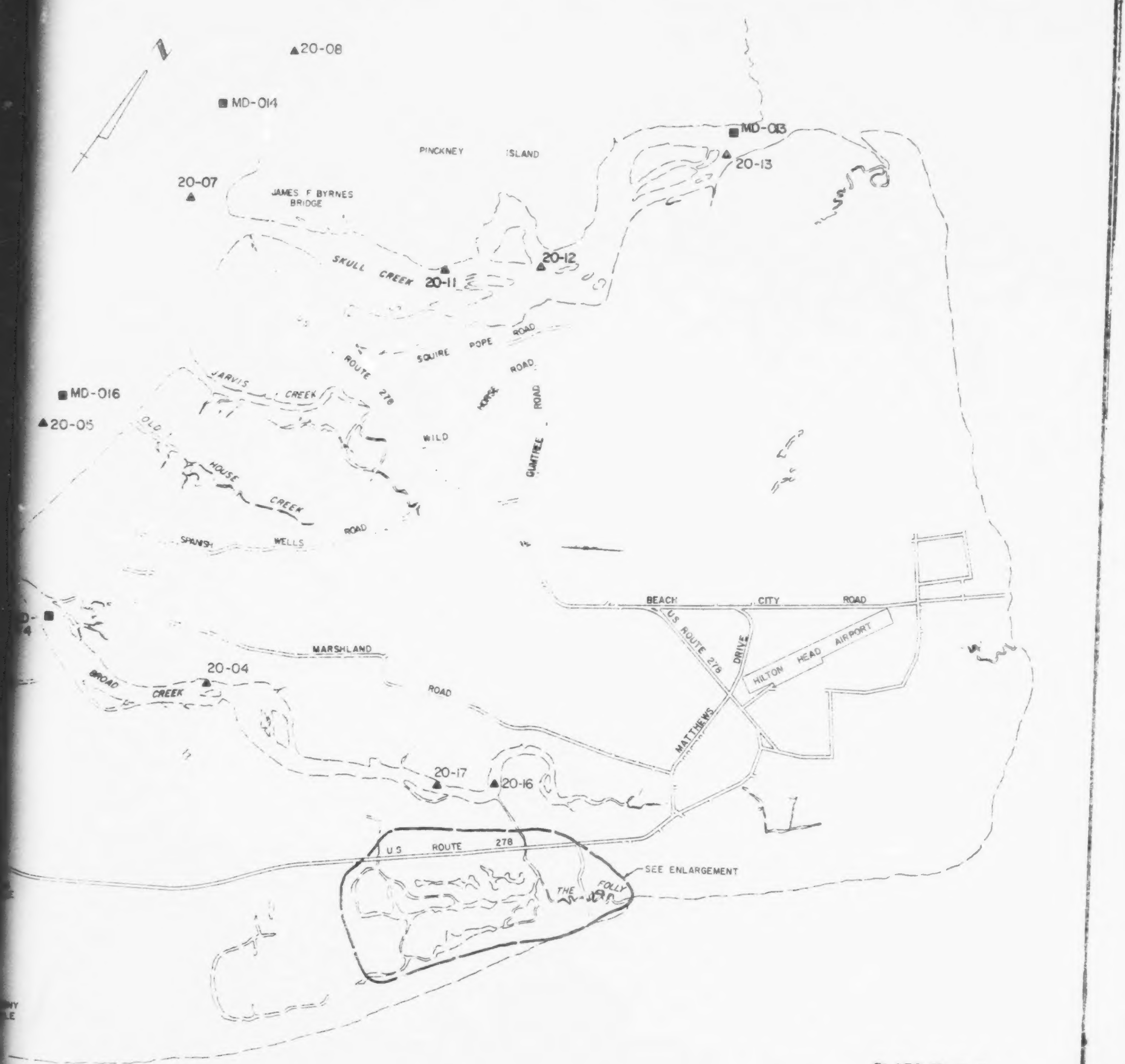

20-08
MD-014
MD-013
20-13
PINCKNEY ISLAND
20-07
JAMES F BYRNES BRIDGE
SKULL CREEK
20-11
20-12
SQUIRE POPE ROAD
ROUTE 278
JARVIS CREEK
MD-016
20-05
OLD HOUSE CREEK
WILD HORSE ROAD
GUMTREE ROAD
SPANISH WELLS ROAD
BEACH CITY ROAD
US ROUTE 278
DRIVE
HILTON HEAD AIRPORT
MARSHLAND ROAD
BROAD CREEK
20-04
MATTHEWS
20-17
20-16
US ROUTE 278
SEE ENLARGEMENT
THE FOLLY

PLATE II-F-2

HILTON HEAD ISLAND
SOUTH CAROLINA

WATER QUALITY STATIONS

3000 0 3000 6000
SCALE IN FEET

US ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

TABLE II-F-7

TOTAL COLIFORM COUNTS IN THE FOLLY AND PALMETTO DUNES, SEPTEMBER 2, 1973

Station	Total Coliform (MPN/100ml)	
	High Tide	Low Tide
1	9	43
1	14	23
2	93	240
3	39	20
4	1,100	150
L3	150	460
L4	14	20
L5	4	460
L6	460	1,100
L8	1,100	1,100
L11	150	460

1) Three Tube, Three Decimal Dilution

2) Stations 1-4 in Folly Creek

3) Stations "L" in Lagoon of Palmetto Dunes

4) References: Windom, Herbert L. 1973. Environmental Impact Assessment for Closing the Folly, Hilton Head Island, South Carolina. Revised 1978. Hussey, Gay and Bell, Consulting Engineers, Savannah, Georgia.

TABLE II-F-8

TOTAL AND FECAL COLIFORM LEVELS IN FOLLY CREEK (F), THE PALMETTO DUNES LAGOON SYSTEM (L) AND BROAD CREEK (B) AREAS
APRIL 1979

Station	Total Coliform (MPN/100 ml)		Fecal Coliform (MPN/100 ml)	
	Dry Period	Wet Period	Dry Period	Wet Period
F1	70	542	<2	2
F2	43	109	<2	4
F3	918	348	2	2
F4	348	43	6	4
F5	70	130	4	5
F6	918	348	2	<2
F7	348	542	<2	<2
F8	918	240	<2	2
F9	172	348	5	<2
F10	43	31	2	<2
F11	470	348	4	6
F12	348	221	<2	<2
L1	240	1,300	2	2
L2	542	918	<2	4
L3	918	1,609	<2	<2
L4	130	542	<2	4
L5	>1,600	>1,600	<4	<2
B1	542	109	2	4
B2	109	141	<2	2
B3	221	94	<2	<2
B4	109	221	4	<2

Reference: Andrews, J. W. and D. R. Kendall, 1979. Environmental Impacts of Closing Folly Creek, Hilton Head Island, South Carolina. Savannah Laboratories.

Lagoon System, even though surrounding residences are sewered. This indicates the source is non-point in origin.

Ambient Water Quality Stations of the Hilton Head Area

Ambient water quality stations have been established by the Stream and Facility Monitoring Section of DHEC to monitor the Class SA waters around Hilton Head (Tables II-F-9 and 10, Plate II-F-2). Although adequate sampling runs would appear to exist for statistical analyses, it is felt that too many changes, as the result of development, have taken place on Hilton Head Island between 1973 and 1979 that could affect water quality. Therefore the evaluation of data is qualitative in nature.

High total coliform counts suddenly appear in 1979 at stations MD-16 and MD-175 which both lie off Broad Creek, a portion of which is presently closed to oyster harvesting. An extremely high total coliform count of 2400 MPN/100ml was observed at station MD-174 on May 26, 1976. This station is located up Broad Creek and was last sampled at the occurrence of this high total coliform count.

Other than station MD-013, fecal coliform counts were no longer collected at ambient stations after 1975. High fecal coliform counts were observed at site MD-174 in 1974 and 1975 (Table II-F-10).

Unfortunately these data do not allow any firm conclusions to be made, although certain inferences can readily be drawn. The north side of Broad Creek is on septic tanks along Marshland Road and Spanish Wells Plantation Road. These septic tanks could result in high bacterial counts if they are malfunctioning. Additionally a number of marinas exist on Broad Creek. Many complaints have been made by the public that boats docked at marinas throughout Hilton Head Island discharge their sewage overboard, thereby affecting local water quality. At this time marinas are not required to have pump-out facilities nor are all boats required to treat sewage prior to discharge overboard.

As of January 30, 1980 all vessels with toilets in coastal waters will be required by Federal law to have Coast Guard approved toilets that provide various levels of treatment which are then discharged to the surface waters, or which store raw sewage until pump-out facilities can be found. From this date on, it will be illegal to discharge untreated sewage from toilets on boats within three miles of the mainland. Additionally, the Governor may petition the USEPA to declare certain State waters as "no discharge" areas. A major question which must be addressed is whether on-board treatment of

TABLE II-F-9
TOTAL COLIFORM COUNTS FROM STATE OF SOUTH CAROLINA CLASS SA WATER QUALITY MONITORING STATIONS AROUND HILTON HEAD ISLAND

Station/Date	Total Coliform MPN (Number/100 ml)
MD-013 (Mouth of Skull Creek at Broad River)	
11-1-74 (Total Coliforms Not Analyzed Prior to This Date)	2
MD-014 (Mackay Creek at Buckingham Landing)	
11-1-74 (Total Coliforms Not Analyzed Prior to This Date)	33
MD-016 (Mouth of May River West of Mark R29)	
10-9-75 (Total Coliforms Not Analyzed Prior to This Date)	8
8-18-76	2
10-21-76	5
5-18-77	2
6-28-77	2
7-21-77	2K
8-30-77	2K
9-27-77	2
5-19-78	5
6-15-78	2
7-5-78	2K
8-28-78	2
5-31-79	2400L
7-31-79	17
MD-174 (Broad Creek at End RD80 Off US278)	
10-1-75 (No Total Coliforms Collected Prior to This Date)	280
4-20-76	49
5-26-76	2400L
MD-175 (Calibogue Sound Near Red Buoy 32)	
11-1-74 (No Total Coliforms Collected Prior to This Date)	14
10-9-75	220
8-18-76	4
10-21-76	8
5-18-77	2K
6-28-77	7

TABLE II-F-9 (Cont'd)
TOTAL COLIFORM COUNTS FROM STATE OF SOUTH CAROLINA CLASS SA WATER QUALITY MONITORING STATIONS AROUND HILTON HEAD ISLAND

Station/Date	Total Coliform MPN (Number/100 ml)
MD-175	
7-21-77	2K
8-30-77	2
9-27-77	4
5-19-78	4
6-15-78	2K
7-5-78	2
8-28-78	4
9-26-78	2K
7-31-79	109

Reference: South Carolina Department of Health and Environmental Control, Compliance Section, Compliance/Enforcement/NPDES Administrative Division.

K: Less Than
L: Greater Than
J: Estimated Value, Not Accurate

TABLE II-F-10
FECAL COLIFORM COUNTS FROM STATE OF SOUTH CAROLINA CLASS SA WATER QUALITY MONITORING STATIONS AROUND HILTON HEAD ISLAND

Station/Date	Fecal Coliform MPN (Number/100 ml)
MD-013 (Mouth of Skull Creek at Broad River)	
6-9-72	20
8-25-72	10
9-22-72	40
5-25-73	0
7-26-73	0
8-24-73	10
5-31-74	2L
7-3-74	3
7-26-74	200L
8-30-74	3
10-3-74	5
11-1-74	2K
5-23-75	5
6-18-75	2K
8-13-75	2K
10-9-75	2K
8-18-76	1
10-21-76	5J
5-18-77	1
6-28-77	1
7-21-77	1K
8-30-77	1
9-27-77	1K
5-19-78	1K
6-15-78	1K
7-5-78	1
8-28-78	1K
9-26-78	2
5-31-78	1K
7-31-79	3
MD-014 (Mackay Creek at Buckingham Landing)	
10-29-71	20
5-25-73	0
6-29-73	0
7-26-73	3
8-24-73	0
5-31-74	2L
7-3-74	2K
7-26-74	2K
8-30-74	3
3-10-74	2K
11-1-74	10

TABLE II-F-10 (Cont'd)
FECAL COLIFORM COUNTS FROM STATE OF SOUTH CAROLINA
CLASS SA WATER QUALITY MONITORING STATIONS AROUND HILTON HEAD ISLAND

Station/Date	Fecal Coliform MPN (Number/100 ml)
MD-014	
5-23-75	2K
8-13-75	2K
10-9-75	3
MD-016 (Mouth of May River West of Mark R29)	
6-9-72	110
8-25-72	10
9-22-72	30
5-25-73	0
6-29-73	0
7-26-73	0
8-24-73	0
5-31-74	2L
7-3-74	2K
7-26-74	8
8-30-74	3
10-3-74	2K
11-1-74	2K
5-23-75	2K
6-18-75	2K
8-13-75	2K
10-9-75	5
MD-174 (Broad Creek at End Rd.80 off U.S.278)	
6-2-72	58
7-10-72	45
8-4-72	100
10-6-72	0
12-11-72	70
3-27-73	0
5-2-73	6
6-21-73	0
7-5-73	0
8-31-73	3
9-18-73	0
10-11-73	40

TABLE II-F-10 (Cont'd)
FECAL COLIFORM COUNTS FROM STATE OF SOUTH CAROLINA CLASS SA WATER QUALITY MONITORING STATIONS AROUND HILTON HEAD ISLAND

Station/Date	Fecal Coliform MPN (Number/100 ml)
MD-174	
5-24-74	10
6-18-74	800K
8-6-74	13
8-27-74	200L
9-9-74	5
10-16-74	10
5-5-75	2K
5-28-75	8
7-30-75	10
9-3-75	100
MD-175 (Calibogue Sound Near Red Buoy 2)	
6-9-72	40
8-25-72	10
9-22-72	20
5-25-73	10
6-29-73	0
7-26-73	3
8-24-73	5
5-31-74	2L
7-3-74	3
7-26-74	3
8-30-74	2K
3-10-74	8
11-1-74	13
5-23-75	2K
6-18-75	2
8-13-75	2
10-9-75	49

References:
a) Beaufort County 201, South Carolina

b) South Carolina Department of Health and Environmental Control, Compliance Section, Compliance/Enforcement/NPDES Administrative Division

c) K: Less Than
L: Greater Than
J: Estimated Value, Not Accurate

sewage will be adequate to maintain Class SA waters.

Shellfish Water Quality Monitoring Stations Around Hilton Head Island

These stations are permanent water quality monitoring stations used by the Shellfish and Recreational Waters Division, Bureau of Special Environmental Programs, DHEC to evaluate waters in judging their ability to meet public health criteria, necessary before the harvesting of shellfish from these waters can be allowed (Table II-F-11, Plate II-F-2). Because of the period of time over which these samples have been collected and the many changes which have taken place on Hilton Head Island that could affect water quality, these sites are evaluated in qualitative terms rather than by statistical analyses. Because of computer malfunctions at the time of this report DHEC was not able to supply sampling data prior to 1977 (Personal Communication, Luke Hause, DHEC).

Station 20-01 at times has fecal coliform counts higher than desirable based upon U. S. FDA criteria. This station drains Braddock Cove and Baynard Creek, both of which are heavily developed. The north side of Baynard Creek is surrounded by homes on septic tanks. Malfunctions could contribute to these high fecal coliform readings. Additionally Braddock Cove has a marina where over-board discharge of sewage by boats while at dock could be contributing to these elevated fecal coliforms. Insufficient data exist from this baseline information to draw conclusions.

TABLE II-F-11

TOTAL COLIFORM AND FECAL COLIFORM COUNTS FROM SHELLFISH MONITORING STATIONS, HILTON HEAD ISLAND, SOUTH CAROLINA[1]

Station/Date		Time/Tide[2]	Total Coliform MPN (Number/100 ml)	Fecal Coliform MPN (Number/100 ml)
20-01	3-8-77	1400/1/2L	70	46
	3-15-77	1015/3/4L	13	5
	4-26-77	0854/ L	5	2
	5-31-77	0925/ H	49	49
	6-23-77	0720/3/4L	2	2
	2-15-78	1025/1/2H	46	8
	3-22-78	0830/1/4L	79	49
	3-28-78	1445/3/4L	13	8
	4-24-78	1042/ H	14	4
	7-10-78	1004/1/2H	<2	<2
	8-2-78	0812/ H	5	5
	3-27-79	1358/3/4L	34	27
20-02	3-8-77	1355/1/2L	542	7
	3-15-77	1010/3/4L	8	5
	4-26-77	0847/ L	8	2
	5-31-77	0920/ H	5	<2
	6-23-77	0714/3/4L	2	2
	2-15-78	1015/1/2H	23	5
	3-22-78	0825/1/4H	13	<2
	3-28-78	1439/3/4L	4	2
	4-24-78	1035/ H	2	<2
	7-10-78	0925/1/2H	<2	<2
	3-2-78	0805/ H	8	33
	3-27-79	1350/3/4L	5	70
20-03	3-8-77	1407/1/2L	17	7
	3-15-77	1020/3/4L	49	13
	4-26-77	0900/ L	23	23
	5-31-77	1035/ H	33	5
	6-23-77	0726/3/4L	2	2
	2-15-78	1035/1/2H	33	5
	3-22-78	0840/1/4H	13	2
	3-28-78	1457/3/4L	13	5
	4-24-78	1110/ H	17	7
20-04	3-8-77	1415/1/2L	22	5
	3-15-77	1030/3/4L	8	8
	4-26-77	0906/ L	4	4
	5-31-77	0945/ H	13	5
	6-23-77	0735/3/4L	13	5
	2-15-78	1035/1/2H	5	2
	3-28-78	1430/3/4L	2	<2
	3-22-78	0850/1/4H	17	5
	4-24-78	1055/ H	2	17
	7-10-78	1030/1/2H	4	2

TABLE II-F-11

TOTAL COLIFORM AND FECAL COLIFORM COUNTS FROM SHELLFISH MONITORING STATIONS, HILTON HEAD ISLAND, SOUTH CAROLINA[1]
(Cont'd)

Station/Date		Time/Tide[2]	Total Coliform MPN (Number/100 ml)	Fecal Coliform MPN (Number/100 ml)
20-04	8-2-78	0915/ H	11	5
	3-27-79	1427/3/4L	14	11
20-05	3-8-77	1345/1/2L	13	8
	3-15-77	1000/3/4L	2	2
	4-26-77	0837/ L	<2	<2
	5-31-77	0910/ H	33	2
	6-23-77	0705/3/4L	<2	<2
	2-15-78	1005/1/2H	49	<2
	3-22-78	0815/1/4H	5	2
	3-28-78	1430/3/4L	5	5
	4-24-78	1030/ H	2	<2
	7-10-78	0947/1/2H	<2	<2
	8-2-78	0800/ H	5	<2
	3-27-79	1425/3/4L	23	5
20-06	3-8-77	1340/1/2L	17	11
	3-15-77	0955/3/4L	33	13
	4-26-77	0833/ L	13	2
	5-31-77	0905/ H	2	<2
	6-23-77	0700/3/4L	13	13
	2-15-78	0950/1/2H	23	<2
	3-22-78	1025/ H	4	2
	3-28-78	1425/3/4L	2	<2
	7-10-78	0945/1/2H	<2	2
	8-2-78	0955/ H	<2	<2
	3-27-79	1440/3/4L	11	17
20-07	3-8-77	1330/1/2L	13	<2
	3-15-77	0930/3/4L	17	11
	4-26-77	0825/ L	5	2
	5-31-77	0900/ H	7	<2
	6-23-77	0650/3/4L	<2	<2
	2-15-78	0935/1/2H	5	<2
	3-22-78	0800/1/4H	<2	<2
	3-28-78	1421/3/4L	2	2
	4-24-78	1020/ H	2	<2
	7-10-78	0935/1/2H	5	<2
	8-2-78	0950/ H	<2	<2
	3-27-79	1518/3/4H	7	2

TABLE II-F-11

TOTAL COLIFORM AND FECAL COLIFORM COUNTS FROM SHELLFISH MONITORING STATIONS, HILTON HEAD ISLAND, SOUTH CAROLINA[1]
(Cont'd)

Station/Date		Time/Tide[2]	Total Coliform MPN (Number/100 ml)	Fecal Coliform MPN (Number/100 ml)
20-08	3-8-77	1510/1/2L	8	5
	3-15-77	1115/3/4L	9	<2
	4-26-77	0943/ L	2	<2
	5-31-77	1030/ H	4	2
	6-23-77	0830/ L	2	2
	3-22-78	0935/1/4H	7	2
	3-28-78	1620/3/4L	11	5
	4-24-78	1150/ H	2	2
	7-10-78	1120/1/2H	2	<2
	8-2-78	1000/ H	240	240
	3-27-79	1510/3/4L	5	2
	2-15-78	0935/1/2H	4	2
20-09	3-8-77	1500/1/2L	22	7
	3-15-77	1105/3/4L	5	5
	4-26-77	0936/ L	<2	<2
	5-31-77	1025/ H	23	8
	6-23-77	0825/ L	<2	<2
	2-15-78	1125/1/2H	2	<2
	3-22-78	0925/1/4H	5	5
	3-28-78	1150/3/4L	11	2
	4-24-78	1150/ H	17	<2
	7-10-78	1120/1/2H	<2	<2
	8-2-78	0945/ H	5	2
	3-27-79	1505/3/4L	<2	<2
20-10	3-8-77	1440/1/2L	49	11
	3-15-77	1045/3/4L	5	<2
	4-26-77	0919/ L	8	2
	5-31-77	1000/ H	8	5
	6-23-77	0759/3/4L	5	2
	2-15-78	1100/1/2H	5	5
	3-28-78	1530/3/4L	8	8
	3-22-78	0905/1/4H	5	2
	4-24-78	1022/ H	5	<2
	7-10-78	1052/1/2H	<2	<2
	8-2-78	0930/ H	<2	<2
	3-27-79	1445/3/4L	13	2
20-11	3-8-77	1443/1/2L	4	4
	3-25-77	1047/3/4L	15	5
	4-26-77	0723/ H	11	<2
	5-31-77	1005/ H	7	5
	6-23-77	0806/ L	8	<2
	2-15-78	1105/1/2H	8	2

TABLE II-F-11

TOTAL COLIFORM AND FECAL COLIFORM
COUNTS FROM SHELLFISH MONITORING
STATIONS, HILTON HEAD ISLAND, SOUTH CAROLINA[1]
(Cont'd)

Station/Date		Time/Tide [2]	Total Coliform MPN (Number/100 ml)	Fecal Coliform MPN (Number/100 ml)
20-11	3-22-78	0910/1/4H	9	10
	3-28-78	1535/3/4L	5	2
	4-24-78	1025/ H	2	<2
	7-10-78	1105/1/2H	<2	<2
	8-2-78	0935/ H	<2	<2
	3-27-79	1448/3/4L	17	13
20-12	3-8-77	1445/1/2L	7	11
	3-15-77	1052/3/4L	5	5
	4-26-77	0927/ L	23	13
	5-31-77	1010/ H	13	5
	6-23-77	0812/1/2H	<2	<2
	2-15-78	1110/1/2H	4	2
	3-22-78	0915/1/4H	11	5
	3-28-78	1542/3/4L	2	<2
	4-24-78	1130/ H	17	2
	7-10-78	1110/1/2H	5	2
	8-2-78	0940/ H	5	5
	3-27-79	1450/3/4L	8	2
20-13	3-8-77	1147/1/2L	2	2
	3-15-77	1100/3/4L	4	4
	4-26-77	0931/ L	5	2
	5-31-77	1015/ H	5	5
	6-23-77	0820/ L	2	2
	2-15-78	1020/1/2H	<2	<2
	3-22-78	0920/1/4H	5	5
	3-28-78	1557/1/2L	5	2
	4-24-78	1135/ H	11	2
	7-10-78	1115/1/2H	2	<2
	8-2-78	0940/ H	<2	<2
	3-27-79	1500/3/4L	5	2
20-14	3-28-78	1448/1/2L	17	11
	4-24-78	1045/ H	23	8
	7-10-78	1015/1/2H	11	22
	8-2-78	0820/ H	342	240
	3-27-79	1406/3/4L	172	77
20-15	3-22-78	0835/1/4H	22	14
	3-28-78	0815/1/2L	22	14
	4-24-78	1100/ H	7	2
	7-10-78	1009/1/2H	13	8
	8-2-78	0815/ H	8	8
	3-27-79	1400/3/4L	27	17

TABLE II-F-11

TOTAL COLIFORM AND FECAL COLIFORM COUNTS FROM SHELLFISH MONITORING STATIONS, HILTON HEAD ISLAND, SOUTH CAROLINA[1]

(Cont'd)

Station/Date		Time/Tide[2]	Total Coliform MPN (Number/100 ml)	Fecal Coliform MPN (Number/100 ml)
20-16	3-28-78	1515/1/2L	5	2
	8-2-78	0920/ H	23	8
	3-27-79	1420/3/4L	2	<2
20-17	3-28-78	1454/ -	240	2
	7-10-78	1035/1/2H	<2	<2
	8-2-78	0923/ H	5	2
	3-27-79	1425/3/4L	<2	<2
20-18	3-28-78	1515/ -	49	22
	4-24-78	1105/ H	17	11
	7-10-78	1022/1/2H	33	33
	8-2-78	0905/ H	33	49
	3-27-79	1412/3/4L	5	2
20-19	3-28-78	- -	240	2
	4-24-78	1052/ -	23	2

1) Source: South Carolina Department of Health and Environmental Control (DHEC), Bureau of Special Environmental Programs, Shellfish Section.

2) Tides:
a) H = High Tide
b) L = Low Tide
c) Fraction = Fraction of Hour Before High or Low Tide

Between stations 20-02 thru 20-13 both total and fecal coliform counts appear to be low. Station 20-14 lying just south of 20-01 and affected in a similar manner also shows high fecal coliform counts as well as high total coliform counts towards the middle of 1978 and on into 1979. Stations 20-15, 20-16 and 20-17 on Broad Creek, and Station 20-19 off of Harbour Town Marina do not indicate unusually high fecal or total coliform counts. Station 20-18 lying in the Lawton Creek area does indicate higher than desirable fecal coliform counts although at the same time total coliform counts do not appear unusually high.

It should be noted that while sites 20-15, 20-16 and 20-17 did not indicate high coliform counts in 1978 and 1979, sites B-1 thru B-4 (Table II-F-8) collected by another study and which drain into sites 20-16 and 20-17, indicated high total coliform counts in 1979.

Coliform Counts From the Hilton Head Non-Point Source (NPS)

Historical Problem Perspective

This section presents bacterial data from the Lawton Canal and Broad Creek areas, which was collected by the Bureau of Special Environmental Programs, Shellfish Section and then compiled in a report by the 208 Division of DHEC (Table II-F-12, Plate II-F-3). As with previous baseline information, these data do not lend themselves to quantitative analysis. In reviewing these data the Sea Pines effluent is observed to have extremely low coliform counts while after rains most other stations show increases in both total and fecal coliform counts. It would appear from these observations that pollution in Lawton Canal and Broad Creek, which has led to the closing of oyster beds, is

TABLE II-F-12
COLIFORM COUNTS FROM THE HILTON HEAD NON-POINT SOURCE (NPS)
HISTORICAL PROBLEM PERSPECTIVE, HILTON HEAD ISLAND, SOUTH CAROLINA,
DECEMBER 12, 1978 THROUGH MARCH 7, 1979

Location and Station Number	Date/Tide[2]	Weather If Noted	Total Coliform MPN (Number/100 ml)	Fecal Coliform MPN (Number/100 ml)	Fecal Streptococci MPN (Number/100 ml)	Salinity[4] 0/00
Sea Pines Treatment Plant Effluent, 1-1	No Date	Rain	< 2	< 2	-	-
Point Where Ditch With Sea Pines Plant Effluent Enters Lawton Canal, 1-2	No Date	Rain	278	79	-	-
Point Above Where Discharge From Sea Pines Plant Effluent Enters Ditch That Leads To Lawton Canal, 1-3	No Date	Rain	490	141	-	-
Lawton Canal at Greenwood Drive 1-4	No Date	Rain	4900	130	-	-
Lawton Canal Above Where Ditch Enters Carrying Effluent, 1-5	No Date	Rain	4300	2300	-	-
Sea Pines Treatment Plant Effluent, 2-1a	1-9-79/L	-	109	109	-	0
	2-12-79/L	-	<2	<2	-	0
	3-7-79/L	Rain	<2	<2	-	0
	4-2-79/H	-	14	<2	-	-
Tide-Gate, 2-1	2-12-78	-	240	130	32	25
	1-9-79/L	-	221	46	-	-
	2-12-79	-	172	17	-	8
	3-7-79/L	Rain	1600	175	-	2
	4-2-79/H	-	920	46	-	-
Lawton Creek, 2-2	2-12-78	-	49	49	38	30
	1-9-79/L	-	172	33	-	28
	2-12-79/½L	-	240	240	-	21
	3-7-79/L	Rain	1600	79	-	4
Calibogue Cay, 2-3	2-12-78	-	49	49	16	29
	1-9-79/L	-	14	2	-	28
	2-12-79	-	7	2	-	29
	3-7-79/L	Rain	542	79	-	10
	4-2-79/L	-	49	49	-	-
Lawton Creek, 2-4	2-12-78	-	23	23	92	29
	1-9-79/L	-	79	23	-	28
	2-12-79	-	49	33	-	22
	3-7-79/L	Rain	920	172	-	12
	4-2-79/L	-	348	348	-	-
Lawton Creek At Broad Creek, 2-5	2-12-78	-	49	17	64	29.5
	1-9-79/L	-	22	11	-	28
	2-12-79	-	22	13	-	29
	3-7-79	Rain	172	70	-	20
Broad Creek Closure Lines, 2-6	2-12-78	-	8	5	12	30
	1-9-79/L	-	17	11	-	28
	2-12-79	-	3	2	-	32
	3-7-79/L	Rain	33	2	-	24.5
	4-2-79/H	-	8	5	-	-

TABLE II-F-12
COLIFORM COUNTS FROM THE HILTON HEAD NON-POINT SOURCE (NPS) HISTORICAL PROBLEM PERSPECTIVE, HILTON HEAD ISLAND, SOUTH CAROLINA, DECEMBER 12, 1978 THROUGH MARCH 7, 1979 (Cont'd.)

Location and Station Number	Date/Tide [2]	Weather If Noted	Total Coliform MPN (Number/100 ml)	Fecal Coliform MPN (Number/100 ml)	Fecal Streptococci MPN (Number/100 ml)	Salinity* o/oo
Broad Creek North 100 Yards Below Closure Sign, 2-7	2-12-78	-	2	2	<4	30
	1-9-79/L	-	5	2	-	28
	2-12-79	-	<2	<2	-	32
	3-7-79/L	Rain	172	13	-	24.5
	4-2-79/H	-	22	<2	-	-
Broad Creek Across From Canal, 2-8	2-12-78	-	5	5	28	29
	1-9-79/L	-	4	<2	-	28
	2-12-79	-	2	2	-	32
	3-7-79/L	Rain	5	5	-	26
	4-2-79/H	-	2	2	-	-
100 Yards Up Point Comfort Creek, 2-9	2-12-78	-	23	23	20	29.5
	1-9-79/L	-	14	7	-	28
	2-12-79/L	-	2	2	-	29
	3-7-79/L	Rain	348	39	-	20
	4-2-79/L	-	4	31	-	-
Upper Back Creek, 1L	8-22-78	Within 24 hrs. After Rainfall	240	33	20	-
	7-18-78/I	-	348	120	120	-
Mid-Point Up Back Creek, 2L	8-22-78	Within 24 hrs. After Rainfall	79	49	44	-
	7-18-78/I	-	130	49	450	-
Lower End of Back Creek, 3L	7-18-78/I	-	49	33	-	-
Near Confluence of Back Creek and Broad Creek, 4L	8-22-78	Within 24 hrs. After Rainfall	49	33	40	-
	8-9-78	-	120	13	-	-
	8-29-78/L	-	23	8	8	-
	7-18-78/I	-	70	31	-	-
Upper End of Back Creek, 5L	8-14-78/Near Low	-	240	27	240	-
	7-18-78	-	141	49	-	-
Flood Gate, 6L	8-22-78	Within 24 hrs. After Rainfall	2400	172	110	-
	8-9-78	-	900	172	-	-
	8-29-78/L	-	920	79	60	-
	8-14-78	-	240	79	-	-
Discharge Ditch, 7L	8-14-78/Near Low	-	2400	1600	32	-
	8-22-78	Within 24 hrs. After Rainfall	1600	348	68	
Broad Creek 1.5 Miles South of Lawton Creek, 8L	8-14-78/Near Low	-	79	49	4	-
	8-22-78	Within 24 hrs. After Rainfall	23	13	<4	-
	8-29-78/L	-	17	17	-	-
9L	8-22-78	Within 24 hrs. After Rainfall	348	78	-	-

TABLE II-F-12
COLIFORM COUNTS FROM THE HILTON HEAD NON-POINT (NPS)
HISTORICAL PROBLEM PERSPECTIVE, HILTON HEAD ISLAND, SOUTH CAROLINA,
DECEMBER 12, 1978 THROUGH MARCH 7, 1979 (Cont'd.)

Location and Station Number	Date/Tide[2]	Weather If Noted	Total Coliform MPN (Number/100 ml)	Fecal Coliform MPN (Number/100 ml)	Fecal Streptococci MPN (Number/100 ml)	Salinity[4] 0/00
Head Water Back Creek, 12L	8-22-78	Within 24 hrs. After Rainfall	240	33	20	-
Mid Back Creek, 13L	8-22-78	Within 24 hrs. After Rainfall	49	11	210	-
Lower End of Back Creek, 14L	8-22-78	Within 24 hrs. After Rainfall	348	109	72	-
Ground Storage Entrance, 20L	8-22-78	Within 24 hrs. After Rainfall	2400	2400	340	-
Beside Forest Beach Pump Station, 21L	8-22-78	Within 24 hrs. After Rainfall	2400	2400	400	-
Night Heron, 22L	8-22-78	Within 24 hrs. After Rainfall	348	210	100	-
Lagoon Between Night Heron and Sea Pines Academy, 23L	8-9-78	-	>2400	-	>2400	-
	8-22-78	Within 24 hrs. After Rainfall	2400	2400	380	-
Lagoon Between Sea Pines Drive and Lawton Rd., 24L	8-9-78	-	900	2400	-	-
	8-22-78	Within 24 hrs. After Rainfall	2400	109	-	-
Pump Storage From Lagoon Down Night Heron, 25L	8-22-78	Within 24 hrs. After Rainfall	2400	2400	-	-
Fairwood Villas By Pump Station, 26L	8-22-78	Within 24 hrs. After Rainfall	1600	109	-	-
Sea Pines Discharge Canal, 27L	8-22-78	Within 24 hrs. After Rainfall	>2400	1600	600	-
Sea Pines STP Lagoon, 28L	8-22-78	Within 24 hrs. After Rainfall	>2400	>2400	24	-
Lawton Farm Lagoon, 29L	8-22-78	Within 24 hrs. After Rainfall	542	22	<4	-
Heritage Farm to Lawton Canal, 30L	8-22-78	Within 24 hrs. After Rainfall	542	49	140	-
Oyster Landing Road, 31L	8-22-78	Within 24 hrs. After Rainfall	1600	172	130	-
Golf Course Spray Holding Tank, 32L	8-22-78	Within 24 hrs. After Rainfall	542	109	290	-
Waterway Marker #4, 33L	8-29-78/L	-	<2	<2	20	-
Second Small Creek on Right After Opening to Broad Creek, 34L	8-29-78/L	-	8	2	<4	-

TABLE II-F-12
COLIFORM COUNTS FROM THE HILTON HEAD NON-POINT (NPS) HISTORICAL PROBLEM PERSPECTIVE, HILTON HEAD ISLAND, SOUTH CAROLINA, DECEMBER 12, 1978 THROUGH MARCH 7, 1979 (Cont'd.)

Location and Station Number	Date/Tide[2]	Weather If Noted	Total Coliform MPN (Number/100 ml)	Fecal Coliform MPN (Number/100 ml)	Fecal Streptococci MPN (Number/100 ml)	Salinity[4] o/oo
1000 Feet From Palmetto Bay Marina, 35L	8-29-78/L	-	11	7	4	-
P-10	8-22-78	Within 24 hrs. After Rainfall	348	79	-	-
P-11	8-22-78	Within 24 hrs. After Rainfall	79	49	-	-

1) Reference: South Carolina Department of Health and Environmental Control (DHEC), Bureau of Special Environmental Programs, Shellfish Section.

2) Back Creek is same as Calibogue Cay.

3) Tides: a) H = High Tide
b) L = Low Tide
c) I = Incoming Tide

4) 0/00 - parts per thousand

very likely coming from increased run-off and/or leaching septic tanks rather than from point sources of pollution such as the Sea Pines Wastewater Treatment Plant. Increased run-off after rainfall occurs because of development which results in increased areas with impermeable surfaces (ie homes, pavement and parking lots) that fail to trap rain water as would vegetation. Vegetation allows water to infiltrate and percolate into the shallow groundwater aquifer. Associated with this run-off is increased sedimentation into the surface waters carrying vegetation, soils and fecal material from animals such as cats, dogs, horses and wildlife that possibly contribute to the high coliform counts seen in the surface waters of the area.

An attempt was made to interpret ratios of fecal coliform/fecal streptococci concentrations in order to see if indications of human or non-human pollution could be observed (Table II-F-13). Certain limitations exist in using these ratios. For statistical reasons, fecal streptococci MPN values should be greater than or equal to 100 organisms/100ml. Additionally, it is preferable to use these ratios in samples collected at the point source of pollution or in surface waters a short distance from the point of contamination. Once organisms of fecal origin become diffused into the receiving waters the duration of their survival and thus the value of their ratios will be governed by a variety of environmental factors including high salinities and low pH's. In general, point and non-point ratios are most reliable if collected at the point of contamination of surface waters and within 24 hours after discharging into surface waters. For non-point run-off this would infer collecting surface water samples within 24 hours after rainfall has occurred to determine if a given non-point source of pollution is human or non-human in origin.

TABLE II-F-13

FECAL COLIFORM/FECAL STREPTOCOCCI RATIOS FROM THE HILTON HEAD NON-POINT SOURCE (NPS) HISTORICAL PROBLEM PERSPECTIVE, HILTON HEAD ISLAND, SOUTH CAROLINA, DECEMBER 12, 1978 THRU MARCH 7, 1979

Station/Date	FC/FS	Interpretation
1L / 7-18-78	172/120 = 1.4	Not Interpretable
2L / 7-18-78	49/450 = 0.1	Possible Non-Human Pollution
5L / 8-14-78	27/240 = 0.1	Possible Non-Human Pollution
6L / 8-22-78	172/110 = 1.6	Not Interpretable
13L / 8-22-78	11/210 = 0.05	Non-Human Pollution
20L / 8-22-78	>2,400/340 = ≥7.1	Human Pollution
21L / 8-22-78	>2,400/400 = ≥6.0	Human Pollution
22L / 8-22-78	210/100 = 2.1	Not Interpretable
23L / 8-22-78	2,400/380 = 6.3	Human Pollution
24L / 8-22-78	109/190 = 0.6	Non-Human Pollution
27L / 8-22-78	1,600/600 = 2.7	Not Interpretable
30L / 8-22-78	49/140 = 0.35	Non-Human Pollution
31L / 8-22-78	172/130 = 1.32	Not Interpretable
32L / 8-22-78	109/290 = 0.38	Human Orgin But Ratio Low Due to Chlorination at STP.

1) Ratio Only Computed for Samples With Fecal Streptococci Having MPN Values of 100 Organisms Per 100 ml or Greater.

2) a) FC/FS = 4 or Higher, Indicates Human Pollution.
   b) FC/FS <0.6, Warm Blooded Source of Pollution Other Than Human.
   c) FC/FS = 0.7 - 3.0, Often Indicates Aging Bacteria In Surface Waters, Not Interpretable.
   d) Samples Taken on August 22, 1978 were Collected Within 24 Hours of Officially Recorded Rainfall, US Weather Bureau Station, Beaufort SC.

3) References:

   a) DHEC, Bureau of Special Environmental Programs, Shellfish Division
   b) Analysis by Gannett Fleming Corddry and Carpenter, Inc.

Based upon these limitations, information in Table II-F-13 has been evaluated. Stations 2L and 5L located on Back Creek (Calibogue Cay) indicate possible non-human pollution although these samples were not taken within 24 hours after rainfall and their value is questionable.

The following samples were collected on August 22, 1978 within 24 hours after rain fell. Site 13L on Back Creek indicates non-human pollution, although a large portion of Back Creek is on septic tanks. Sites 20L and 21L indicate human pollution. Site 21L was taken from surface waters beside the Forest Beach Pump Station, possibly indicating malfunctioning of this sewage pumping station and contamination of surface waters. Site 30L taken from surface waters between Heritage Farm and Lawton Canal indicates non-human pollution, very likely occurring from runoff of the horse stables located in this vicinity.

Bacterial Levels From a Special Non-Point Source Study

Because high coliform counts in surface waters resulted in the closing of Lawton Creek and a portion of Broad Creek to shellfish harvesting, and because of the discharge from the Sea Pines Wastewater Treatment Plant (STP), a special water quality study was undertaken by the DHEC Division of Biological Stream and Facility Monitoring. The purpose of this study was to analyze the effects of the Sea Pines discharge on water quality as well as determine the contribution from other possible non-point sources of pollution, (Table II-F-14, Plate II-F-3). Where appropriate fecal coliform/fecal streptococci ratios have been computed from these data to determine if pollution was human or non-human in origin (Table II-F-15). As with previous baseline data presented in this chapter, there is not enough information to perform statistical analyses nor to draw more definitive conclusions.

The most important findings of this study indicated that the Sea Pines STP, at the time of sampling, was not providing adequate disinfection as indicated by often reduced chlorine residual values, ranging between 0.5 - 0.0 mg/1, and the elevated bacterial values in the effluent (see S-6, Table II-F-14). Coliform concentrations in station S-5 were many times higher than found in the effluent. These elevated coliform values remain in Lawton Canal and on into Lawton Creek through Stations S-4, S-3, S-2, and S-1. Although not taken directly after a rainfall event, fecal coliform/ fecal streptococci ratios in all cases indicate possible non-human pollution causing these elevated levels of bacterial counts. Additionally, since these elevated bacterial counts cannot be tied to specific sources of pollution other than the Sea Pines discharge, it must be assumed that increases in bacterial levels above that found in the Sea Pines effluent are originating from non-point sources of pollution (i.e. leaching septic tanks, run-off and marinas). Together with the Sea Pines discharge, these non-point sources contributed to the elevated bacterial counts.

TABLE II-F-14

COLIFORM LEVELS FROM A SPECIAL STUDY OF POTENTIAL NON-POINT SOURCES OF POLLUTION AROUND HILTON HEAD ISLAND, SOUTH CAROLINA, SEPTEMBER 1978

Station/Date		Time/Tide	Total Coliform MPN (Number/100 ml)	Fecal Coliform MPN (Number/100 ml)	Fecal Streptococci MPN (Number/100 ml)
S-1	9-13-78	0600/H	79	8	50
	9-13-78	0900/M	348	-	-
	9-13-78	1330/L	33	17	380
	9-13-78	1500/M	49	-	-
	9-13-78	1800/H	79	5	29
	9-14-78	1230/L	>2400	348	200
	9-15-78	0800/H	14	9	40
S-2	9-13-78	0600/H	542	79	170
	9-13-78	0900/M	240	-	-
	9-13-78	1330/L	542	94	60
	9-13-78	1500/M	70	-	-
	9-13-78	1800/H	240	79	19
	9-14-78	1230/L	1600	348	300
	9-15-78	0800/H	79	33	46
S-3	9-13-78	0600/H	348	79	56
	9-13-78	0900/M	542	-	-
	9-13-78	1330/L	>2400	221	44
	9-13-78	1500/M	348	-	-
	9-13-78	1800/H	221	17	25
	9-14-78	1230/L	920	130	400
	9-15-78	0800/H	33	33	76
S-4	9-13-78	0600/H	>2400	920	330
	9-13-78	0900/M	>2400	-	-
	9-13-78	1330/L	>2400	172	75
	9-13-78	1500/M	1600	-	-
	9-13-78	1800/H	>2400	221	370
	9-14-78	1230/L	>2400	175	45
	9-15-78	0800/H	1600	278	110
S-5	9-13-78	0600/H	920	172	290
	9-13-78	0900/M	920	-	-
	9-13-78	1330/L	>2400	141	270
	9-13-78	1500/M	1600	-	-
	9-13-78	1800/H	>2400	920	380
	9-14-78	1230/L	1600	70	77
	9-15-78	0800/H	920	49	150

TABLE II-F-14 (Cont'd)

Station/Date		Time/Tide	Total Coliform MPN (Number/100 ml)	Fecal Coliform MPN (Number/100 ml)	Fecal Streptococci MPN (Number/100 ml)
S-6	9-13-78	0600/H	33	33	3
	9-13-78	0900/M	23	-	-
	9-13-78	1330/L	240	79	25
	9-13-78	1500/M	49	-	-
	9-13-78	1800/H	542	70	12
	9-14-78	1230/L	1600	1600	23
	9-15-78	0800/H	70	70	7
S-7	9-13-78	0630/H	49	17	38
	9-13-78	1330/L	79	17	18
	9-15-78	1230/L	542	348	26
	9-15-78	0800/H	25	22	11
S-8	9-13-78	0630/H	33	33	-
	9-13-78	1330/L	348	172	-
	9-14-78	1230/L	46	33	-
	9-15-78	0800/H	33	33	-
S-9	9-13-78	0630/H	5	5	-
	9-13-78	1330/L	49	33	-
	9-14-78	1230/L	33	33	-
	9-15-78	0800/H	172	79	-
S-10	9-13-78	0630/H	33	8	-
	9-13-78	1330/L	23	13	-
	9-14-78	1230/L	130	79	-
	9-15-78	0800/H	49	33	-
S-11	9-13-78	0630/H	17	2	-
	9-13-78	1330/L	49	5	-
	9-14-78	1230/L	542	141	-
	9-15-78	0800/H	79	22	-
S-12	9-13-78	0630/H	22	17	-
	9-13-78	1330/L	13	8	-
	9-14-78	1230/L	33	11	-
	9-15-78	0800/H	33	23	-
S-13	9-13-78	0630/H	13	5	-
	9-13-78	1330/L	17	13	-
	9-14-78	1230/L	23	5	-
	9-15-78	0800/H	130	27	-
S-14	9-13-78	0630/H	5	2	-
	9-13-78	1330/L	130	49	-
	9-14-78	1230/L	46	8	-
	9-15-78	0800/H	31	17	-

TABLE II-F-14 (Cont'd)

1) Reference: South Carolina Department of Health and Environmental Control (DHEC), Division of Biological Stream and Facility Monitoring, Bureau of Analytical and Biological Services (Formerly the Monitoring-Stream, Potable Water and Facilities Section under the Division of District Services).

2) Tides:
   a) H = High Tide
   b) L = Low Tide
   c) M = Midway Between High and Low or Low and High Tides

3) S-6: Sea Pines Sewage Treatment Plant Effluent

TABLE II-F-15

FECAL COLIFORM/FECAL STREPTOCOCCI RATIOS
FROM A SPECIAL STUDY OF POTENTIAL NON-POINT
SOURCES OF POLLUTION AROUND HILTON HEAD ISLAND,
SOUTH CAROLINA, SEPTEMBER 1978

Station/Date		FC/FS	Interpretation
S-1	9-13-78	17/380 = 0.04	Possible Non-Human Pollution
	9-14-78	348/200 = 1.74	Not Interpretable
S-2	9-13-78	79/170 = 0.46	Possible Non-Human Pollution
	9-14-78	348/300 = 1.16	Not Interpretable
S-3	9-14-78	130/400 = 0.33	Possible Non-Human Pollution
S-4	9-13-78	920/330 = 2.79	Not Interpretable
	9-13-78	221/370 = 0.60	Possible Non-Human Pollution
	9-15-78	278/110 = 2.52	Not Interpretable
S-5	9-13-78	172/290 = 0.59	Possible Non-Human Pollution
	9-13-78	141/270 = 0.52	Possible Non-Human Pollution
	9-13-78	920/380 = 2.55	Not Interpretable
	9-15-78	49/150 = 0.33	Possible Non-Human Pollution

1) Ratio only computed for samples with fecal streptococci having MPN values of 100 organisms per 100 ml or greater.

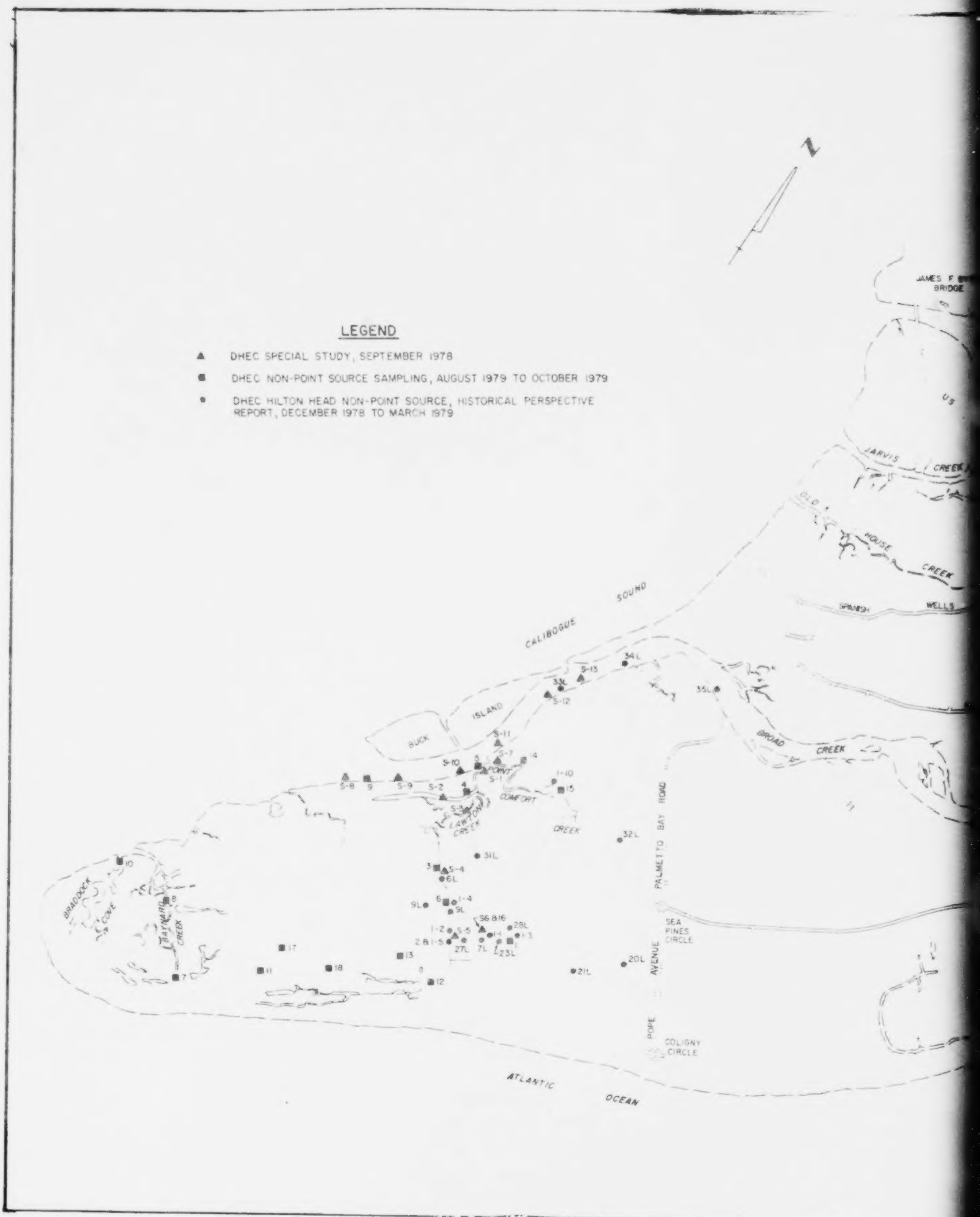
2) a) FC/FS = 4 or higher, indicates human pollution.
   b) FC/FS $<$ 0.6, warm blooded source of pollution other than human.
   c) FC/FS = 0.7 - 3.0, often indicates aging bacteria in surface waters, not interpretable.

3) Rainfall on the night of September 14, 1978.

4) References:

   a) Raw Data: South Carolina Department of Health and Environmental Control (DHEC), Division of Biological Stream and Facility Monitoring, Bureau of Analytical and Biological Services.

   b) Interpretation of ratios: Gannett Fleming Corddry and Carpenter, Inc.


N
LEGEND
▲ DHEC SPECIAL STUDY, SEPTEMBER 1978
■ DHEC NON-POINT SOURCE SAMPLING, AUGUST 1979 TO OCTOBER 1979
● DHEC HILTON HEAD NON-POINT SOURCE, HISTORICAL PERSPECTIVE REPORT, DECEMBER 1978 TO MARCH 1979
JAMES F. B BRIDGE
US
JARVIS CREEK
OLD HOUSE CREEK
SPANISH WELLS
CALIBOGUE SOUND
BUCK ISLAND
BROAD CREEK
S-13
34L
33L
S-12
35L
S-11
S-7
14
S-10
5
POINT
S-1
1-10
15
S-8
9
S-9
S-2
4
COMFORT
S-3
LAWTON CREEK
CREEK
32L
31L
PALMETTO BAY ROAD
10
3
S-4
6L
BRADDOCK COVE
8
BAYNARD CREEK
6
1-4
9L
9L
S6 & 16
28L
1-2
S-5
1-1
1-3
2 & 1-5
27L
7L
23L
SEA PINES CIRCLE
17
13
20L
11
18
0
21L
7
12
POPE AVENUE
COLIGNY CIRCLE
ATLANTIC OCEAN

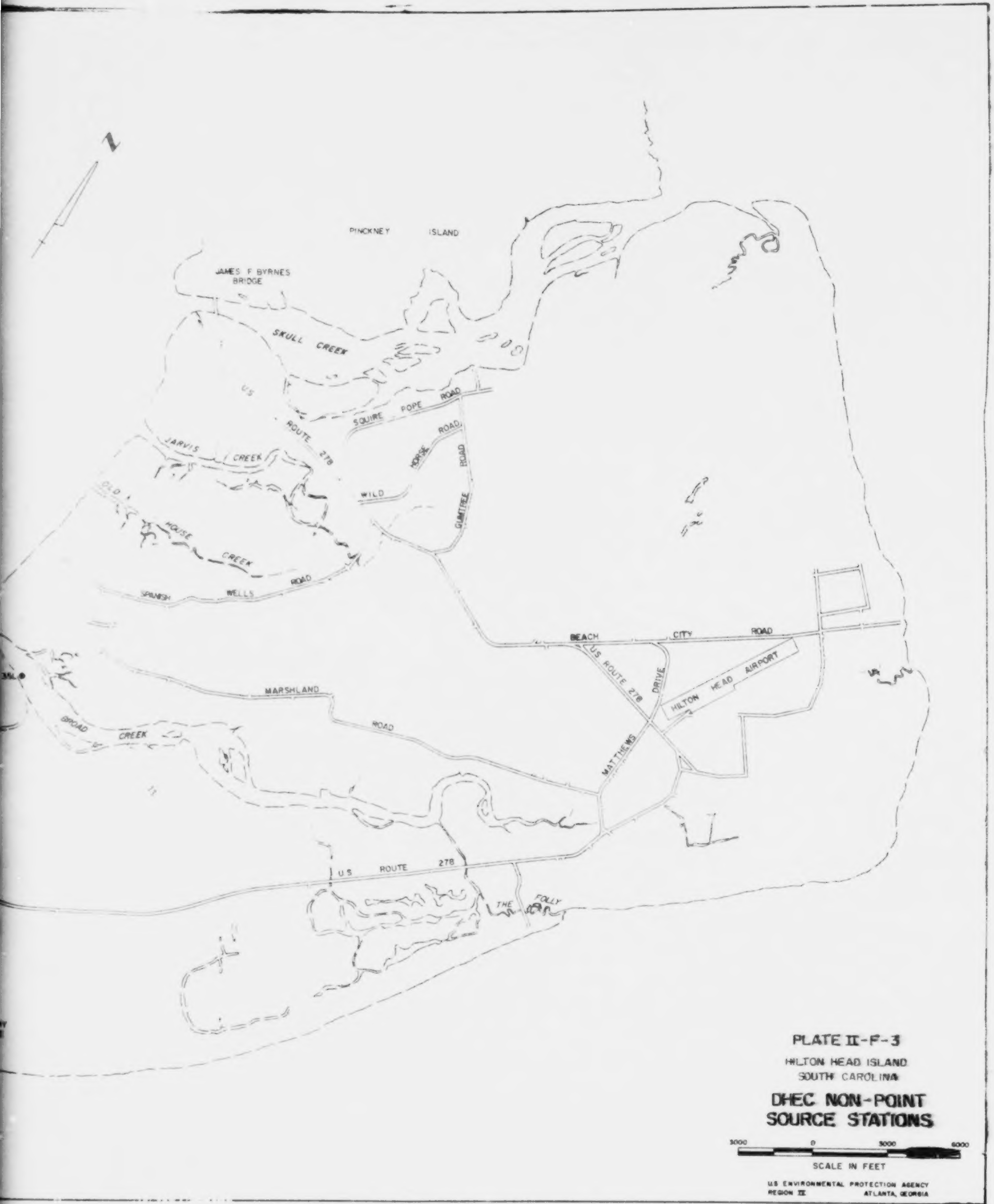

N
PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
US ROUTE 278
SQUIRE POPE ROAD
WILD HORSE ROAD
GUMTREE ROAD
JARVIS CREEK
OLD HOUSE CREEK
SPANISH WELLS ROAD
BEACH CITY ROAD
US ROUTE 278
MATTHEWS DRIVE
HILTON HEAD AIRPORT
MARSHLAND ROAD
BROAD CREEK
U.S. ROUTE 278
THE FOLLY
3000
0
3000
6000
SCALE IN FEET

PLATE II-F-3

HILTON HEAD ISLAND
SOUTH CAROLINA

DHEC NON-POINT SOURCE STATIONS

US ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

SUMMARY

Based upon existing water quality data, a portion of Broad Creek and Lawton Creek were closed to shellfish harvesting because of high total coliform counts. Available data indicate that non-point source pollution is primarily responsible for the elevated coliform counts. Unfortunately, inadequate sampling runs exist to perform statistical analyses or to draw definitive conclusions as to the exact sources of these non-point pollutants. As a result, the Division of Biological Stream and Facilities Monitoring and Emergency Response of DHEC has undertaken a detailed study of the Lawton Creek, Broad Creek area taking 24-hour tidal samples of surface waters during wet (rain) and dry events. Samples will be analyzed for fecal coliform, fecal streptococci, total coliform and various heavy metals to see if the sources of pollution around this area can be better understood and various management alternatives developed to ameliorate this problem. Preliminary results from this study are discussed in the next chapter.

CHAPTER II-G

DHEC NONPOINT SOURCE ASSESSMENT STUDY FINDINGS

The closure of a portion of the oyster beds on Broad Creek by DHEC has precipitated intensive study in order to evaluate the impact of point and nonpoint sources of pollution on these waters, with emphasis on bacterial contamination. This study is being conducted in waters contiguous to the Sea Pines Plantation by the DHEC Division of Biological Stream and Facility Monitoring. The findings from this study, integrated into the Hilton Head EIS, will play an important role in providing information necessary to develop wastewater management alternatives for the island. The first sampling took place on August 13-15, 1979 and represented a dry climatical period. This was followed by water quality sampling during a rainy event on September 1-3, 1979, and a dry event on October 17-19, 1979. Additionally, a groundwater monitoring program was conducted in various areas of suspected nonpoint source contributors within the Sea Pines Plantation during November and December 1979 and January 1980.

STUDY AREA

The study area encompasses portions of Sea Pines Plantation in the southwest portion of Hilton Head Island. The study area and sampling station locations are shown in Plate II-G-1. A list of sampling station locations appears in Table II-G-1.

Hilton Head Island, particularly the southwest side, is a rapidly growing resort area. The island is bordered by the Atlantic Ocean, Calibogue Sound, and Broad Creek. Tidal creeks flush into Calibogue Sound and the Broad Creek area. Of particular concern is the Lawton Creek watershed (Segment I), located on the northern side of Sea Pines with its mouth directly south of Buck Island. This area has been recently closed for shellfishing due to bacterial contamination. Baynard Creek watershed (Segment II) located approximately two miles west of Lawton Creek has similar characteristics; however, the drainage area for Lawton Creek receives waste from Sea Pines' wastewater treatment facility while Baynard Creek does not contain a direct discharge in its drainage area. Point Comfort Creek watershed (Segment III) was also examined as a potential source of contamination of Broad Creek. These areas are being developed as single and multi-family dwelling sites with associated commercial growth. Sewers are utilized by approximately 70% of the area.

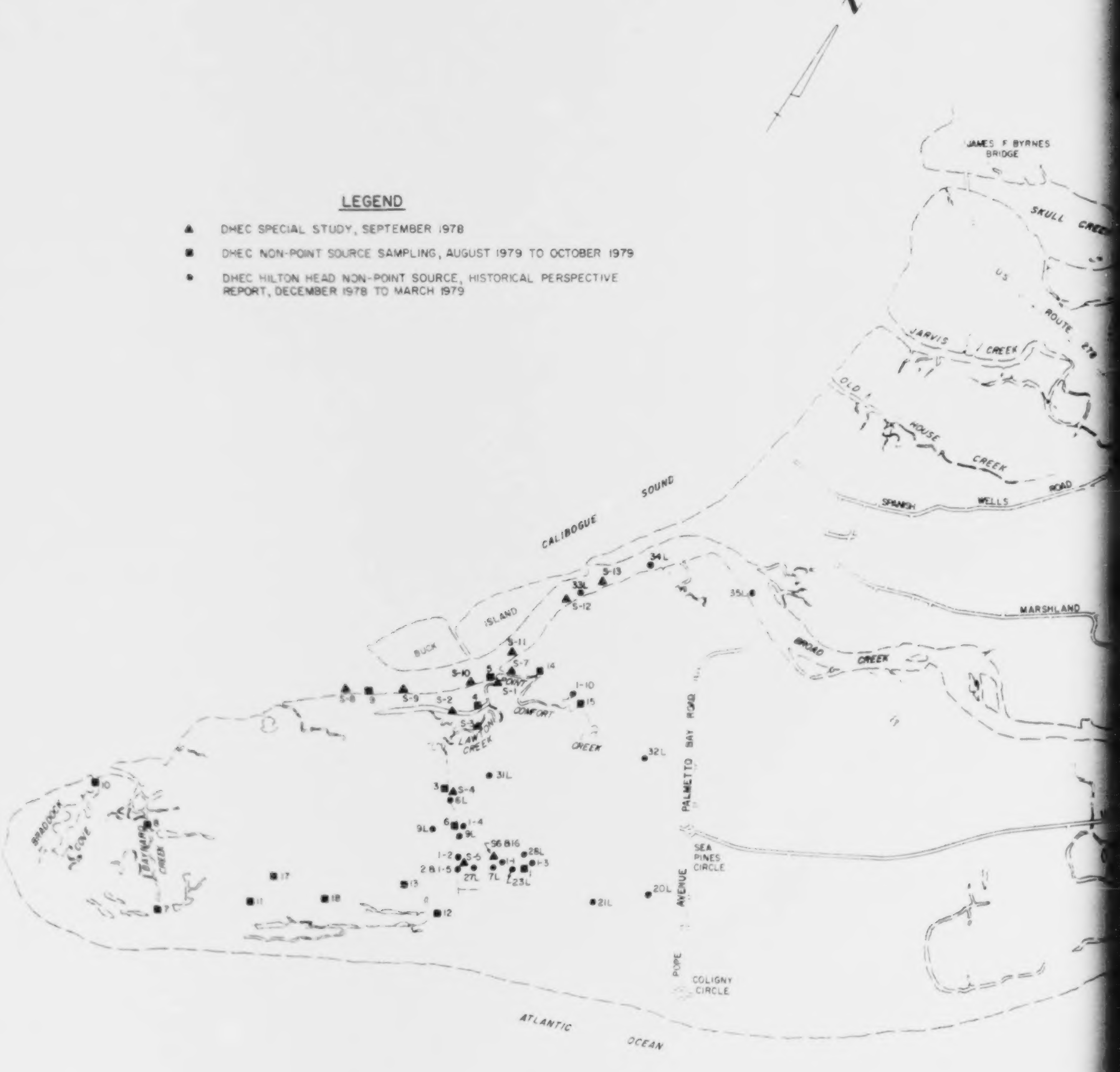
METHODOLOGY

Water quality and bacteria samples were collected during dry and wet periods in order to evaluate the extent of point and nonpoint source contamination. Dry weather sampling occurred during August 13-15, 1979, with bacteria samples collected on six (6) separate occasions, three (3)

TABLE II-G-1

HILTON HEAD NONPOINT SOURCE ASSESSMENT
Station Description

Station	
#1	Above the effluent from Sea Pines STP. Also serves as drainage from the Forest Preserve. This station has been shown to be affected by tides.
#2	Culvert draining under Lawton Road. This shows the drainage from some sewered and unsewered area. Also will receive road and golf course drainage.
#3	Lawton Creek, located off of Oyster Landing Road. This station will represent flow being discharged from Lawton Canal to Broad Creek through Lawton Creek.
#4	Back Creek, located before the confluence with Lawton Creek. This station will identify drainage from the Calibogue Cay area.
#5	Lawton Creek, located prior to the confluence with Broad Creek.
#6	Lawton Creek, located at the foot bridge approximately 300 yards from Greenwood Drive. This station will be affected by drainage occurring in the area bordered by Lighthouse Road, Greenwood Drive, Norta Sea Pines Drive and the Forest Preserve.
#7	Drainage area near southeastern end of Baynard Creek. The area which is drained is within Lighthouse Road, North Sea Pines Drive, Plantation Drive, and Baynard Cove Road.
#8	Located in Baynard Creek.
#9	Broad Creek, located at the proposed boundary by FDA (conditionally approved area).
#10	Braddock Cove, located to represent an existing marina as well as unsewered areas.
#11	Drainage area on North Sea Pines Drive near Greenwood Court.
#12	Drainage for Live Oak Road area and North Sea Pines Drive. Has both sewered and unsewered areas.
#13	Drainage for unsewered area of Red Maple Road.
#14	Point Comfort Creek, above unsewered area at Point Comfort.
#15	Point Comfort Creek, below unsewered area at Point Comfort.
#16	Effluent from Sea Pines PSD.
#17	Drainage from a sewered area near Battery Road.
#18	Drainage from unsewered area along North Sea Pines Drive and south to the ocean.



LEGEND

▲ DHEC SPECIAL STUDY, SEPTEMBER 1978

■ DHEC NON-POINT SOURCE SAMPLING, AUGUST 1979 TO OCTOBER 1979

● DHEC HILTON HEAD NON-POINT SOURCE, HISTORICAL PERSPECTIVE REPORT, DECEMBER 1978 TO MARCH 1979

N
JAMES F BYRNES BRIDGE
SKULL CREEK
US ROUTE 278
JARVIS CREEK
OLD HOUSE CREEK
SPANISH WELLS ROAD
CALIBOGUE SOUND
MARSHLAND
BROAD CREEK
BUCK ISLAND
S-13
34L
33L
S-12
35L
S-11
S-7
14
S-10
5
POINT
S-1
S-8
9
S-9
S-2
4
S-3
COMFORT
CREEK
LAWTON CREEK
1-10
15
32L
PALMETTO BAY ROAD
31L
10
BRADDOCK COVE
3
S-4
6L
8
BAYNARD CREEK
6
1-4
9L
9L
S6 8 16
28L
1-2
S-5
1-1
1-3
2 8 1-5
27L
7L
23L
1
SEA PINES CIRCLE
17
13
18
11
12
7
21L
20L
AVENUE
POPE
COLIGNY CIRCLE
ATLANTIC OCEAN

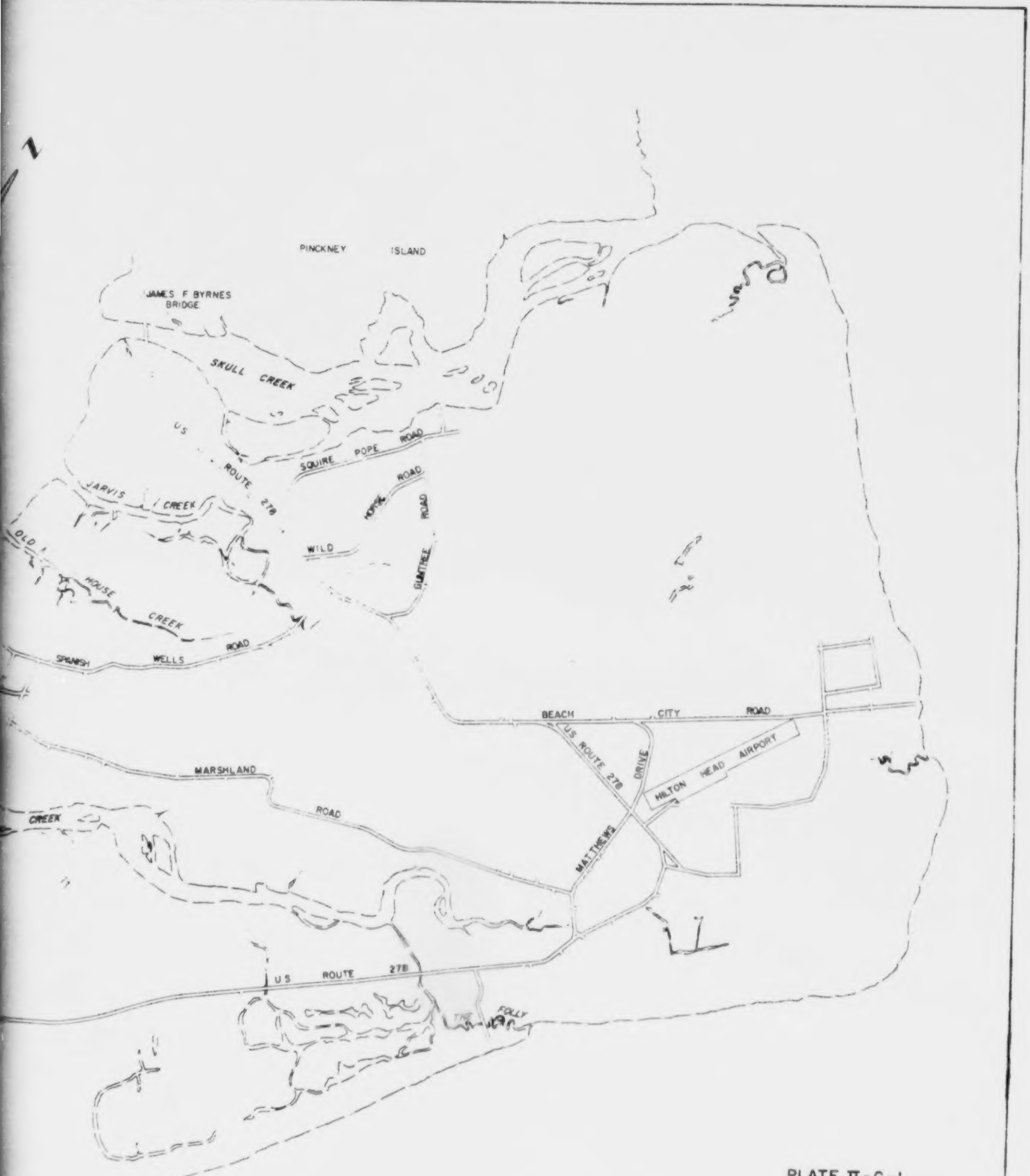

PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
US ROUTE 278
SQUIRE POPE ROAD
JARVIS CREEK
OLD HOUSE CREEK
WILD HORSE ROAD
GUMTREE ROAD
SPANISH WELLS ROAD
BEACH CITY ROAD
US ROUTE 278
MATTHEWS DRIVE
HILTON HEAD AIRPORT
MARSHLAND ROAD
CREEK
U.S. ROUTE 278
THE FOLLY

PLATE II-G-1

HILTON HEAD ISLAND
SOUTH CAROLINA

DHEC NON-POINT SOURCE STATIONS

3000 0 3000 6000

SCALE IN FEET

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

times on high slack tide and three (3) times on low slack tide. Chemical parameters such as dissolved oxygen, pH, temperature, and conductivity were measured at each of the samplings. Metals, pesticides, and herbicides were collected on selected low tide samplings.

Wet weather sampling occurred on September 1-3, 1979. The sampling period occurred over six (6) consecutive tidal cycles. Bacteriological and chemical parameters were collected at each of the samplings while metals, pesticides, and herbicides were collected from selected stations.

Rainfall was measured at Stations #8, #12, and #18 through the use of two (2) visual rain gauges and one (1) automatic recording rain gauge. The automatic rain gauge measured 1.62 inches of rain at Station #18, while Stations #18 and #12 wer approximately two (2) inches and 0.5 inches, respectively.

Dry weather sampling again took place from October 17-19, 1979. Samples were collected over a complete tidal cycle, three times at high slack and three times at low slack tide. Biological samples were analyzed for total coliform, fecal coliform and fecal streptococcus. Physio-chemical samples of dissolved oxygen, temperature (°C) and conductivity were also evaluated at this time. Samples to be analyzed for the heavy metals of lead, mercury and zinc were collected on the second and third low tides. Pesticides and herbicides were analyzed from various samples collected on the third low tide.

RESULTS AND DISCUSSION - BACTERIA

Raw data from the August, September and October 1979 sampling runs are contained in Tables II-G-2, 3 and 4. Although it would be preferable to have additional information for statistical analyses, these data were subjected to various computations. Median total coliform values were calculated for comparison to State Class SA and Approved Shellfish Area Standards. Median fecal coliform values were determined for comparison to federal criteria for shellfish waters (Tables II-G-5, 6, and 7). Percentages of total coliforms above an MPN of 230/100 ml were employed to evaluate State standards for Class SA waters while percentages of fecal coliforms above an MPN of 43/100 ml were used for evaluation of federal criteria for shellfish waters (Table II-G-8). Fecal coliform/fecal streptococci ratios aided in detecting whether pollution was human or non-human in origin (Tables II-G-9, 10 and 11). The geometric mean of fecal coliform values was used as it relates to State Class SB standards for swimmable waters (Table II-G-12).

Segment I Lawton Creek Drainage - Bacteria

At present, regardless of the tidal cycle or climatic conditions, the effluent from the Sea Pines Wastewater Treatment Plant had very low bacterial counts. At Stations 1-5 there was a tendency for bacterial levels to increase from high tide to low tide during the August dry weather

TABLE II-G-2

HILTON HEAD NONPOINT SOURCE ASSESSMENT - BACTERIA RESULTS
SEGMENT I - LAWTON CREEK DRAINAGE, AUGUST 13-15, 1979 (DRY EVENT), SEPTEMBER 1-3, 1979 (WET EVENT), AND OCTOBER 17-19, 1979 (DRY EVENT)

Tide	Parameter	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
				AUGUST			
Low	T.C.	>2,400	278	>2,400	172	542	920
	F.C.	920	13	49	130	542	240
	F.S.	700	81	340	260	170*	340
High	T.C.	5	1,600	49	13	8	542
	F.C.	2	109	11	5	5	348
	F.S.	<1*	230	37	5	1	240
Low	T.C.	>2,400	1,600	920	>2,400	240	920
	F.C.	79	17	141	49	240	33
	F.S.	1,100	99	290	49	93	110*
High	T.C.	23	1,600	172	70	2	348
	F.C.	<2	22	49	70	2	79
	F.S.	<1	55	18	1	1*	100*
Low	T.C.	542	542	1,600	130	348	920
	F.C.	8	6	920	49	172	172
	F.S.	72	61	260	13	76	72
High	T.C.	46	240	542	33	5	1,600
	F.C.	<2	15	109	17	5	70
	F.S.	<1	24	30*	2	2	75
				SEPTEMBER			
High	T.C.	>24,000	16,000	3,480	-	-	16,000
	F.C.	1,300	490	1,720	-	-	700
	F.S.	10,000	1,800	670	-	-	2,200
Low	T.C.	>24,000	790	9,200	2,400	9,200	>24,000
	F.C.	1,300	221	490	490	790	426
	F.S.	3,900	430	2,000	2,500	660	1,400*
High	T.C.	>2,400	1,600	2,780	1,720	70	9,200
	F.C.	>2,400	130	1,300	1,090	21	790
	F.S.	4,100	220	770	400	26	850
Low	T.C.	>2,400	542	>2,400	920	920	>2,400
	F.C.	240	17	920	920	920	920
	F.S.	2,300	30*	670	210	280	450
High	T.C.	1,600	920	542	130	8	>2,400
	F.C.	49	46	542	23	8	920
	F.S.	900	210	320	36	66	600
Low	T.C.	>2,400	542	>2,400	348	1,600	>2,400
	F.C.	920	33	348	240	348	221
	F.S.	820	200	580	780	360	560

TABLE II-G-2

HILTON HEAD NONPOINT SOURCE ASSESSMENT - BACTERIA RESULTS
SEGMENT I - LAWTON CREEK DRAINAGE, AUGUST 13-15, 1979 (DRY EVENT)
SEPTEMBER 1-3, 1979 (WET EVENT), AND OCTOBER 17-19, 1979 (DRY EVENT)

				OCTOBER			
Tide	Parameter	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
High	T.C.	1600	350	700	240	8	350
	F.C.	1600	46	330	240	5	130
	F.S.	67	5000	4000	1000	3400	560
Low	T.C.	130	280	350	79	1600	240
	F.C.	5	49	49	79	540	33
	F.S.	16	6300	3600	370	320	1500
High	T.C.	49	700	540	170	7	350
	F.C.	49	79	350	79	11	79
	F.S.	750	530	3100	690	100	2100
Low	T.C.	490	-	330	79	350	920
	F.C.	33	-	130	79	240	79
	F.S.	34	-	3500	250	650	3800
High	T.C.	920	240	330	220	8	1600
	F.C.	170	130	49	110	5	350
	F.S.	210	5700	3000	1900	240	2800
Low	T.C.	350	350	350	920	350	70
	F.C.	<2	110	350	170	240	49
	F.S.	5	5500	2000	500	290	2600

TABLE II-G-2

HILTON HEAD NONPOINT SOURCE ASSESSMENT - BACTERIA RESULTS SEGMENT I - LAWTON CREEK DRAINAGE, AUGUST 13-15, 1979 (DRY EVENT), SEPTEMBER 1-3, 1979 (WET EVENT), AND OCTOBER 17-19, 1979 (DRY EVENT)

Tide	Parameter	Station 9	Station 12	Station 13	Station 16
			AUGUST		
Low	T.C.	8	79	130	<2
	F.C.	2	33	13	<2
	F.S.	28	47	24	5
High	T.C.	5	79	240	8
	F.C.	2	22	17	<2*
	F.S.	<1*	130*	62	4
Low	T.C.	>2,400	172	920	542
	F.C.	4	11	23	<2
	F.S.	<1	1,100*	24	<1*
High	T.C.	>2,400	1,600	1,600	79
	F.C.	2	4	70	<2
	F.S.	2	75	66	5
Low	T.C.	1,600	49	542	23
	F.C.	21	4	5	<2
	F.S.	5	3	39	<1*
High	T.C.	8	13	542	<2
	F.C.	<2	5	49	<2
	F.S.	2	8	40	13
			SEPTEMBER		
High	T.C.	-	2,400	9,200	<2
	F.C.	-	172	84	<2
	F.S.	-	100*	5,200	4
Low	T.C.	221	330	542	4
	F.C.	46	17	49	<2
	F.S.	43	1	1,100*	15
High	T.C.	49	172	>2,400	31
	F.C.	8	2	109	2
	F.S.	26	43	900	<1*
Low	T.C.	109	-	-	5
	F.C.	8	-	-	2
	F.S.	18	-	-	36
High	T.C.	<2	109	>2,400	-
	F.C.	<2	33	49	-
	F.S.	22	43	130*	-
Low	T.C.	49	240	>2,400	13
	F.C.	14	17	79	13
	F.S.	19	41	180*	4

TABLE II-G-2

HILTON HEAD NONPOINT SOURCE ASSESSMENT - BACTERIA RESULTS
SEGMENT I - LAWTON CREEK DRAINAGE, AUGUST 13-15, 1979 (DRY EVENT)
SEPTEMBER 1-3, 1979 (WET EVENT), AND OCTOBER 17-19, 1979 (DRY EVENT)

OCTOBER

Tide	Parameter	Station 9	Station 12	Station 13	Station 16	Station 19
High	T.C.	-	920	920	2	5
	F.C.	2	79	49	2	2
	F.S.	140	290	1900	1	500
Low	T.C.	49	49	1100	2	17
	F.C.	49	8	460	2	11
	F.S.	120	190	2800	36	170
High	T.C.	2	230	490	2	2
	F.C.	2	33	7	2	2
	F.S.	90	170	1300	41	60
Low	T.C.	13	79	1300	2	49
	F.C.	8	23	17	2	13
	F.S.	200	310	1500	33	94
High	T.C.	2	-	700	240	2
	F.C.	2	13	31	2	2
	F.S.	150	2300	390	3	100
Low	T.C.	170	920	170	< 2	6
	F.C.	130	33	17	< 2	2
	F.S.	140	210	580	15	110*

T.C. = Total Coliform F.C. = Fecal Coliform F.S. = Fecal Streptococcus *Estimated Values/100 ml

Reference: DHEC Division of Biological Stream and Facilities Monitoring, and Emergency Responses, State of South Carolina, Interim Report No. 1, November 1979, and Interim Report No. 2, January 1980.

TABLE II-G-3

HILTON HEAD NONPOINT SOURCE ASSESSMENT - BACTERIA RESULTS
SEGMENT II - BAYNARD CREEK DRAINAGE, AUGUST 13-15, 1979 (DRY EVENT), SEPTEMBER 1-3, 1979 (WET EVENT), AND OCTOBER 17-19, 1979 (DRY EVENT).

Tide	Parameter	Section 7	Section 8	Station 11	Station 17	Station 18	Station 10
				AUGUST			
Low	T.C.	130	542	>2,400	920	240	900
	F.C.	13	79	23	94	11	70
	F.S.	11	180*	31	220	61	190*
High	T.C.	49	23	49	240	348	2
	F.C.	33	23	49	17	9	<2
	F.S.	7	3	5	160*	29	<1*
Low	T.C.	79	1,600	120	49	240	>2,400
	F.C.	33	542	33	8	8	109
	F.S.	6	41	10	21	51	73
High	T.C.	109	920	172	>2,400	920	130
	F.C.	<2	23	7	17	2	4
	F.S.	6	<1*	9	22	70	4
Low	T.C.	1,600	348	348	109	542	920
	F.C.	920	348	14	17	5	46
	F.S.	24	170*	12	8	39	21
High	T.C.	13	13	49	130	70	13
	F.C.	13	8	33	130	17	2
	F.S.	4	4	50	44	98	6
				SEPTEMBER			
High	T.C.	>24,000	-	>16,000	9,200	>24,000	-
	F.C.	16,000	-	5,420	430	330	-
	F.S.	7,500	-	10,000	12,000*	330	-
Low	T.C.	>24,000	9,200	>24,000	>24,000	>24,000	348
	F.C.	16,000	790	1,300	1,720	1,090	240
	F.S.	9,200	300	6,000	3,800	>10,000	72
High	T.C.	>24,000	5,420	>2,400	>2,400	>2,400	13
	F.C.	16,000	2,400	542	920	920	<2
	F.S.	10,000	600	3,500	2,500	>10,000	10
Low	T.C.	>2,400	920	>2,400	>2,400	>2,400	240
	F.C.	920	348	1,600	542	348	49
	F.S.	440	730	140*	450	3,500	140*
High	T.C.	>2,400	141	>2,400	>2,400	>2,400	49
	F.C.	920	33	348	542	542	9
	F.S.	330	32	710	3,200	100	68
Low	T.C.	>2,400	542	>2,400	>2,400	240	240
	F.C.	920	348	348	542	79	130
	F.S.	2,500	230	720	680	410	48

TABLE II-G-3

HILTON HEAD NONPOINT SOURCE ASSESSMENT - BACTERIA RESULTS
SEGMENT II - BAYNARD CREEK DRAINAGE, AUGUST 13-15, 1979 (DRY EVENT), SEPTEMBER 1-3, 1979 (WET EVENT), AND OCTOBER 17-19, 1979 (DRY EVENT.

OCTOBER

Tide	Parameter	Section 7	Section 8	Station 11	Station 17	Station 18	Station 10
High	T.C.	170	79	-	920	220	13
	F.C.	79	79	220	540	26	2
	F.S.	760	720	6300	4600	4200	610
Low	T.C.	920	130	3500	2400	79	79
	F.C.	33	130	79	49	13	79
	F.S.	530	400	3300	3300	3700	240
High	T.C.	240	130	790	3500	130	33
	F.C.	79	79	330	790	33	17
	F.S.	260	450	470	2800	3600	180
Low	T.C.	790	490	1100	1700	240	170
	F.C.	330	330	310	490	23	130
	F.S.	340	170	1900	3400	670	350
High	T.C.	240	230	790	790	79	2
	F.C.	130	130	790	170	17	2
	F.S.	790	740	2500	2700	9700	310
Low	T.C.	540	2400	240	>2400	350	49
	F.C.	540	1600	240	350	49	33
	F.S.	630	370	3300	3400	2800	350

T.C. = Total Coliform F.C. = Fecal Coliform F.S. = Fecal Streptococcus *Estimated Values/100 ml

References: DHEC, Division of Biological, Stream and Facilities Monitoring, and Emergency Responses, State of South Carolina, Interim Report No. 1, November 1979, and Interim Report No. 2, January 1980.

TABLE II-G-4

HILTON HEAD NONPOINT SOURCE ASSESSMENT - BACTERIA RESULTS
SEGMENT III - POINT COMFORT CREEK DRAINAGE, AUGUST 13-15, 1979 (DRY EVENT),
SEPTEMBER 1-3 1979 (WET EVENT), AND OCTOBER 17-19 1979 (DRY EVENT)

Tide	Parameter	Station 14	Station 15
AUGUST			
Low	T.C.	49	920
	F.C.	49	920
	F.S.	26	230
High	T.C.	2	70
	F.C.	2	49
	F.S.	3	4
Low	T.C.	109	240
	F.C.	46	130
	F.S.	46	22
High	T.C.	<2	23
	F.C.	<2	13
	F.S.	7	12
Low	T.C.	172	79
	F.C.	31	23
	F.S.	59	21
High	T.C.	<2	21
	F.C.	<2	14
	F.S.	2	9
SEPTEMBER			
High	T.C.	-	240
	F.C.	-	79
	F.S.	-	250
Low	T.C.	348	1,720
	F.C.	49	790
	F.S.	500	800
High	T.C.	33	109
	F.C.	13	109
	F.S.	44	47
Low	T.C.	172	109
	F.C.	49	33
	F.S.	100	71
High	T.C.	17	23
	F.C.	5	2
	F.S.	28	330
Low	T.C.	46	542
	F.C.	23	109
	F.S.	620	500*

TABLE II-G-4
HILTON HEAD NONPOINT SOURCE ASSESSMENT - BACTERIA RESULTS
SEGMENT III - POINT COMFORT CREEK DRAINAGE, AUGUST 13-15, 1979 (DRY EVENT)
SEPTEMBER 1-3 1979 (WET EVENT), AND OCTOBER 17-19 (DRY EVENT)

		OCTOBER	
Tide	Parameter	Station 14	Station 15
High	T.C.	2	49
	F.C.	2	49
	F.S.	490	820
Low	T.C.	540	240
	F.C.	350	240
	F.S.	430	110
High	T.C.	4	13
	F.C.	4	8
	F.S.	140	620
Low	T.C.	350	350
	F.C.	170	170
	F.S.	85	150
High	T.C.	2	7
	F.C.	2	11
	F.S.	150	210
Low	T.C.	540	>2400
	F.C.	240	>2400
	F.S.	210	210

T.C. = Total Coliform F.C. = Fecal Coliform F.S. = Fecal Streptococcus *Estimated Values/100 ml

Reference: DHEC, Division of Biological, Stream and Facilities Monitoring, and Emergency Responses, State of South Carolina, Iterim Report No. 1, November 1979 and Interim Report No. 2, January 1980.

TABLE II-G-5

HILTON HEAD NONPOINT SOURCE ASSESSMENT, MEDIAN VALUES OF
TOTAL (TC) AND FECAL (FC) COLIFORM CONCENTRATIONS, SEGMENT I,
LAWTON CREEK DRAINAGE, AUGUST 13-15, 1979 (DRY EVENT)
SEPTEMBER 1-3, 1979 (WET EVENT), AND OCTOBER 17-19, 1979 (DRY EVENT)

Station	Median TC/FC MPN/100 ml	August 1979			September 1979			October 1979			Combination of Aug. & October 1979 Dry Event Sampling Periods		
		High Tide	Low Tide	Combined	High Tide	Low Tide	Combined	High Tide	Low Tide	Combined	High Tide	Low Tide	Combined
1	TC	23	>2,400	294	>2,400	>2,400	>2,400	920	350	420	48	516	420
	FC	<2	79	5	1,300	920	1,110	170	5	41	24	21	21
2	TC	1600	542	1,071	1,600	542	885	350	315	350	525	350	350
	FC	22	13	16	130	33	88	79	80	79	63	17	46
3	TC	172	1,600	731	2,780	>2,400	2,590	540	350	350	435	635	445
	FC	49	141	79	1,300	490	731	330	130	230	79	136	120
4	TC	33	172	100	925	920	920	220	79	195	120	151	150
	FC	17	49	49	557	490	490	110	79	95	75	79	79
5	TC	5	348	124	39	1,600	920	8	350	179	8	350	124
	FC	5	240	90	15	790	348	5	240	126	5	240	90
6	TC	542	920	920	9,200	>2,400	5,800	350	240	350	416	920	731
	FC	79	172	126	790	426	745	130	49	79	105	64	79
9	TC	8	1,600	804	26	109	49	2	49	13	5	90	13
	FC	2	4	2	5	14	8	2	49	5	2	15	2
12	TC	79	79	79	172	285	240	575	79	230	230	79	79
	FC	5	11	8	33	17	17	33	23	28	18	17	18
13	TC	542	542	542	>2,400	1,471	>2,400	700	1,100	810	621	731	621
	FC	49	13	20	84	64	79	31	17	24	40	17	20
16	TC	8	23	16	17	5	8	2	2	2	5	2	2
(Effluent)	FC	<2	<2	<2	2	2	2	2	2	2	2	<2	<2
19	TC	-	-	-	-	-	-	2	17	6	-	-	-
	FC	-	-	-	-	-	-	2	11	2	-	-	-

References: a) DHEC, Division of Biological, Stream and Facilities Monitoring, and Emergency Responses, State of South Carolina.

b) Analysis by Gannett Fleming Corddry and Carpenter, Inc., 1980.

TABLE II-G-6

HILTON HEAD NONPOINT SOURCE ASSESSMENT, MEDIAN VALUES OF
TOTAL (TC) AND FECAL (FC) COLIFORM CONCENTRATIONS, SEGMENT II,
BAYNARD CREEK DRAINAGE, AUGUST 13-15, 1979 (DRY EVENT),
SEPTEMBER 1-3, 1979 (WET EVENT), AND OCTOBER 17-19, 1979 (DRY EVENT)

Station	Median TC/FC MPN/100 ml	August 1979			September 1979			October 1979			Combination of Aug. & October 1979 Dry Event Sampling Periods		
		High Tide	Low Tide	Combined	High Tide	Low Tide	Combined	High Tide	Low Tide	Combined	High Tide	Low Tide	Combined
7	TC	49	130	94	>24,000	>2,400	13,200	240	790	390	140	665	205
	FC	13	33	23	16,000	920	8,460	79	330	105	56	182	56
8	TC	23	542	445	2,781	920	920	130	490	180	105	516	289
	FC	13	348	51	1,217	348	348	79	330	130	51	339	105
11	TC	49	348	146	> 2,400	>2,400	>2,400	790	1,100	790	172	724	348
	FC	33	23	28	542	1,300	921	330	240	275	135	56	64
17	TC	240	109	185	> 2,400	>2,400	>2,400	920	2,400	2,050	855	1,310	920
	FC	17	17	17	542	542	542	540	350	420	150	72	112
18	TC	348	240	294	> 2,400	>2,400	>2,400	130	240	175	175	240	240
	FC	9	8	9	542	348	445	26	23	25	17	12	15
10	TC	13	920	515	31	240	240	13	79	41	13	535	64
	FC	2	70	25	6	130	49	2	79	25	2	75	25

References: a) DHEC, Division of Biological, Stream and Facilities Monitoring, and Emergency Responses, State of South Carolina

b) Analysis by Gannett Fleming Corddry and Carpenter, Inc., 1980.

TABLE II-G-7

HILTON HEAD NONPOINT SOURCE ASSESSMENT, MEDIAN VALUES OF TOTAL (TC) AND FECAL (FC) COLIFORM CONCENTRATIONS, SEGMENT III, POINT COMFORT CREEK DRAINAGE, AUGUST 13-15, 1979 (DRY EVENT), SEPTEMBER 1-3, 1979 (WET EVENT) AND OCTOBER 17-19, 1979 (DRY EVENT)

		August 1979			September 1979		
Station	MPN/100 ml	High Tide	Low Tide	Combined	High Tide	Low Tide	Combined
14	TC	<2	109	26	25	172	46
	FC	<2	46	17	9	49	23
15	TC	23	240	75	109	542	175
	FC	14	130	36	79	109	94
		October 1979			Combination of August and October 1979 Dry Event Sampling Periods		
14	TC	2	540	177	2	261	27
	FC	2	240	87	2	110	18
15	TC	13	350	145	22	295	75
	FC	11	240	110	14	205	49

References: a) DHEC, Division of Biological, Stream and Facilities Monitoring, and Emergency Responses, State of South Carolina.

b) Analysis by Gannett Fleming Corddry and Carpenter, Inc.

TABLE II-G-8
PERCENT OF TOTAL COLIFORM (TC) VALUES EXCEEDING AN MPN OF 250 ORGANISMS/100 ml, AND PERCENT OF FECAL COLIFORM (FC) VALUES EXCEEDING AN MPN OF 43 ORGANISMS/100 ml

		Percent of Bacterial Concentrations Exceeding The Above Values									Combination of August and October 1979 Dry Event Sampling Periods		
		August 1979 (Dry Event)			September 1979 (Wet Event)			October 1979 (Dry Event)					
Station	TC/FC	High Tide	Low Tide	Combined	High Tide	Low Tide	Combined	High Tide	Low Tide	Combined	High Tide	Low Tide	Combined
					Segment I Lawton Creek Drainage								
1	TC	0	100	50	100	100	100	67	67	67	33	83	58
	FC	0	67	33	100	100	100	100	0	50	50	33	42
2	TC	100	100	100	100	100	100	100	100	100	100	100	100
	FC	33	0	17	100	33	67	100	100	100	67	40	55
3	TC	33	100	67	100	100	100	100	100	100	67	100	83
	FC	67	100	83	100	100	100	100	100	100	83	100	92
4	TC	0	33	17	50	100	80	33	33	33	15	33	25
	FC	33	100	67	50	100	80	100	100	100	67	100	83
5	TC	0	100	50	0	100	60	0	100	50	0	100	50
	FC	0	100	50	0	100	60	0	100	50	0	100	50
6	TC	100	100	100	100	100	100	100	67	83	100	83	92
	FC	100	67	83	100	100	100	100	67	83	100	67	83
9	TC	33	67	50	0	0	0	0	0	0	20	33	27
	FC	0	0	0	0	33	20	0	67	33	0	33	17
12	TC	33	0	17	33	100	60	50	33	40	40	17	27
	FC	0	0	0	33	0	20	33	0	17	17	0	9
13	TC	100	67	83	100	100	100	100	67	83	100	67	83
	FC	67	0	33	100	100	100	33	33	33	50	17	33
16	TC	0	33	17	0	0	0	33	0	17	17	17	17
	FC	0	0	0	0	0	0	0	0	0	0	0	0
					Segment II Baynard Creek Drainage								
7	TC	0	33	17	100	100	100	67	100	83	33	67	50
	FC	0	33	17	100	100	100	100	67	83	50	50	50
8	TC	33	100	67	50	100	80	0	67	67	17	83	67
	FC	0	100	50	50	100	80	100	100	100	50	100	75
11	TC	0	67	33	100	100	100	100	100	100	40	83	64
	FC	33	0	17	100	100	100	100	100	100	67	50	59
17	TC	67	33	50	100	100	100	100	100	100	83	67	75
	FC	33	33	33	100	100	100	100	100	100	67	67	67
18	TC	67	100	83	100	100	100	0	67	33	33	83	58
	FC	0	0	0	100	100	100	0	33	17	0	17	9
10	TC	0	100	50	0	100	60	0	0	0	0	50	25
	FC	0	100	50	0	100	60	0	67	33	0	83	42
					Segment III Point Comfort Creek Drainage								
14	TC	0	0	0	0	33	20	0	100	50	0	50	25
	FC	0	67	33	0	67	40	0	100	50	0	83	42
15	TC	0	67	33	33	67	50	0	100	50	0	83	42
	FC	33	67	50	67	67	67	33	100	67	33	83	59

References: a) DHEC, Division of Biological, Stream and Facilities Monitoring, and Emergency Responses, State of South Carolina

b) Analysis by Gannett Fleming Corddry and Carpenter, Inc., 1980.

TABLE II-G-9

FECAL COLIFORM/FECAL STREPTOCOCCI RATIOS FROM THE HILTON HEAD ISLAND NONPOINT SOURCE ASSESSMENT, INTERIM REPORT NUMBER I, AUGUST 13-15, 1979, DRY EVENT

	Fecal Coliform/Fecal Streptococcus Ratios					
Site	Low Tide	High Tide	Low Tide	High Tide	Low Tide	High Tide
			Segment I Lawton Creek Drainage			
1	920/700=1.3	2/<1*=NA	9/1100=0.01	<2/<1=NA	8/72=NA	2/ 1*=NA
2	13/81=NA	109/230=0.47	17/99=0.17	22/55=NA	5/61=NA	15/24=NA
3	49/340=0.14	11/37=NA	141/290=0.49	49/18=NA	920/260=3.5	109/30*=NA
4	130/260=0.5	5/5=NA	49/49=NA	70/1=NA	49/13=NA	17/2=NA
5	542/170*=3.19	5/1=NA	240/93=NA	2/1*=NA	172/76=NA	5/2=NA
6	240/340=0.71	348/240=1.45	33/110=0.3	79/100=0.79	172/72=NA	70/75=NA
9	2/28=NA	2/<1*=NA	4/<1*=NA	2/2=NA	21/5=NA	<2/2=NA
12	33/47=NA	22/130*=0.17	11/1100*=0.01	4/75=NA	4/3=NA	5/8=NA
13	13/24=NA	17/62=NA	23/24=NA	70/66=NA	5/39=NA	49/40=NA
16 Effluent	<2/5=NA	<2*/4=NA	<2/< *=NA	<2/5=NA	<2/<1*=NA	<2/13=NA
			Segment II Baynard Creek Drainage			
7	13/11=NA	33/7=NA	33/6=NA	<2/6=NA	920/24=NA	13/4=NA
8	79/180*=0.44	13/3=NA	542/41=NA	23/<1*=NA	348/170*=2.05	8/4=NA
11	23/31=NA	49/5=NA	33/10=NA	7/9=NA	14/12=NA	33/50=NA
17	94/220=0.43	17/160*=0.11	8/21=NA	17/22=NA	17/8=NA	130/44=NA
18	11/61=NA	9/29=NA	8/51=NA	2/70=NA	5/39=NA	17/98=NA
10	70/190*=NA	<2/<1*=NA	109/73=NA	4/4=NA	46/21=NA	2/6=NA
			Segment III Point Comfort Creek			
14	49/26=NA	2/3=NA	46/46=NA	<2/7=NA	31/59=NA	<2/2=NA
15	920/230=4.0	49/4=NA	130/22=NA	13/12=NA	23/21=NA	14/9=NA

1) Ratio computed for samples with fecal streptococci concentrations having MPN values of 100 organisms per 100 ml or greater.

2) a) FC/FS=4 or higher, indicates human pollution
   b) FC/FS<6, warm blooded source of pollution other than human.
   c) FC/FS=0.7-3.0, often indicates aging bacteria in surface waters or a mixture of both human and non-human pollutional sources.

3) References:
   a) DHEC, Division of Biological, Stream and Facilities Monitoring and Emergency Responses.
   b) Analysis by Gannett Fleming Corddry and Carpenter, Inc.

4) *: Estimated value. 5) NA=Not Applicable.

TABLE II-G-10

FECAL COLIFORM/FECAL STREPTOCOCCI RATIOS FROM THE HILTON HEAD ISLAND NONPOINT SOURCE ASSESSMENT, INTERIM REPORT NUMBER 1, SEPTEMBER 1-3, 1979, RAIN EVENT

	Fecal Coliform/Fecal Streptococci Ratios					
Site	High Tide	Low Tide	High Tide	Low Tide	High Tide	Low Tide
			Segment I Lawton Creek Drainage			
1	1300/10000=0.13	1300/3900=0.33	2400/4100=0.59	240/2300=0.10	49/900=0.05	920/820=1.12
2	490/1800=0.27	221/430=0.51	130/220=0.59	17/30*=NA	46/210=0.22	33/200=0.17
3	1720/670=2.57	490/2000=0.25	1300/770=1.69	920/670=1.37	542/320=1.69	348/580=0.6
4	-	490/2500=0.20	1090/400=2.73	920/210=4.38	23/36=NA	240/780=0.31
5	-	790/660=1.20	21/61=NA	920/280=3.29	8/66=NA	348/360=0.97
6	700/2200=0.32	426/1400*=0.30	790/850=0.93	920/450=2.04	920/690=1.53	221/560=0.40
9	-	46/33=NA	8/26=NA	8/18=NA	<2/22=NA	14/19=NA
12	172/100=1.72	17/1=NA	2/43=NA	-	33/43=NA	17/41=NA
13	84/5200=0.02	49/1100*=0.05	109/900=0.12	-	49/130*=0.38	79/180*=0.44
16						
Effluent	<2/4=NA	<2/15=NA	2/<1*=NA	2/36=NA	-	13/4=NA
			Segment II Baynard Creek Drainage			
7	16000/7500=2.13	16000/9200=1.74	16000/10000=1.6	920/440=2.09	920/330=2.79	920/2800=0.33
8	-	790/300=2.63	2400/600=4.00	348/730=0.48	33/32=NA	348/230=1.51
11	5420/10000=0.54	1300/6000=0.22	542/3500=0.16	1600/140*=11.43	348/710=0.49	348/720=0.48
17	430/12000*=0.04	1720/3800=0.45	920/2500=0.37	542/450=1.20	542/3200=0.17	542/680=0.75
18	330/15000*=0.02	1090/>10000=0.11	920/>10000=0.09	348/3500=0.10	542/100=5.42	79/410=0.19
10	-	240/72=NA	<2/10=NA	49/140*=0.35	9/68=NA	130/48=NA
			Segment III Point Comfort Creek			
14	-	49/500=0.10	13/44=NA	49/100=0.49	5/28=NA	23/620=0.04
15	79/250=0.32	790/800=1.00	109/47=NA	33/71=NA	2/330=0.01	109/500*=0.22

1) Ratio computed for samples with fecal streptococci concentrations having MPN values of 100 organisms per 100 ml or greater.

2) a) FC/FS=4 or higher, indicates human pollution.
   b) FC/FS<6, warm blooded source of pollution other than human.
   c) FC/FS=0.7-3.0, often indicates aging bacteria in surface waters or a mixture of both human and non-human pollutional sources.

3) References:
   a) DHEC, Division of Biological, Stream and Facilities Monitoring, and Emergency Responses, State of South Carolina.
   b) Analysis by Gannett Fleming Corddry and Carpenter, Inc.

4) *: Estimated value. 5) NA=Not Applicable.

TABLE II-G-11
FECAL COLIFORM/FECAL STREPTOCOCCUS RATIOS FROM THE HILTON HEAD ISLAND
NONPOINT SOURCE ASSESSMENT, INTERIM REPORT NUMBER 2, OCTOBER 17-19 1979,
DRY EVENT

Site	Fecal Coliform/Fecal Streptococcus Ratios					
	High Tide	Low Tide	High Tide	Low Tide	High Tide	Low Tide
			SEGMENT I Lawton Creek Drainage			
1	1600/ 67 = NA	5/ 16 = NA	49/ 750 = 0.07	33/ 44 = NA	170/ 210 = 0.81	<2/ 5 = NA
2	46/5000 = 0.01	49/6000 = 0.01	79/ 530 = 0.15	-	130/5700 = 0.02	110/5500 = 0.02
3	330/4000 = 0.08	49/3600 = 0.01	350/3100 = 0.11	130/3500 = 0.04	49/3000 = 0.02	350/2000 = 0.18
4	240/1000 = 0.24	79/ 370 = 0.21	79/ 690 = 0.12	79/ 250 = 0.32	110/1900 = 0.06	170/ 500 = 0.34
5	5/3400 = 0.002	540/ 320 = 1.69	11/ 100 = 0.11	240/ 650 = 0.37	5/ 240 = 0.02	240/ 290 = 0.83
6	130/560 = 0.23	33/1500 = 0.02	79/2100 = 0.04	79/3800 = 0.02	350/2800 = 0.13	49/2600 = 0.02
9	2/ 240 = 0.01	49/ 120 = 0.41	2/ 90 = NA	8/ 200 = 0.04	2/ 150 = 0.01	130/ 140 = 0.93
12	79/ 290 = 0.27	8/ 190 = 0.04	33/ 170 = 0.19	23/ 310 = 0.07	13/2300 = 0.01	33/ 210 = 0.16
13	49/1900 = 0.03	460/2800 = 0.16	7/1300 = 0.01	17/1500 = 0.01	31/ 390 = 0.08	17/ 580 = 0.03
16 (Effluent)	2/ 1 = NA	2/ 36 = NA	2/ 41 = NA	2/ 33 = NA	2/ 3 = NA	<2/ 15 = NA
19	2/ 500 = 0.004	11/ 170 = 0.07	2/ 60 = NA	13/ 94 = NA	2/ 100 = 0.02	2/ 110* = 0.02
			SEGMENT II Baynard Creek Drainage			
7	79/ 760 = 0.10	33/ 530 = 0.06	79/ 260 = 0.30	330/ 340 = 0.97	130/ 790 = 0.16	540/ 630 = 0.85
8	79/ 720 = 0.11	130/ 400 = 0.33	79/ 450 = 0.18	330/ 170 = 1.94	130/ 740 = 0.18	1600/ 370 = 4.32
11	220/6300 = 0.04	79/3300 = 0.02	330/470 = 0.70	310/1900 = 0.16	790/2500 = 0.32	240/3300 = 0.07
17	540/4600 = 0.12	49/3300 = 0.02	790/2800 = 0.28	490/3400 = 0.14	170/2700 = 0.06	350/3400 = 0.10
18	26/4200 = 0.01	13/3700 = 0.004	33/3600 = 0.01	23/ 670 = 0.03	17/9700 = 0.001	49/2800 = 0.02
10	2/ 610 = 0.003	79/ 240 = 0.33	17/ 180 = 0.09	130/ 350 = 0.37	2/ 320 = 0.01	33/ 350 = 0.09
			SEGMENT III Point Comfort Creek			
14	2/ 490 = 0.004	350/ 430 = 0.81	4/ 140 = 0.03	170/ 85 = NA	2/ 150 = 0.01	240/ 210 = 1.14
15	49/ 820 = 0.06	240/ 110 = 2.18	8/ 620 = 0.01	170/ 150 = 1.13	11/ 210 = 0.05	2400/ 210 =11.43

1) Ratio computed for samples with fecal streptococci concentrations having MPN values of 100 organisms per 100 ml or greater.
2) a) FC/FS=4 or higher, indicates human pollution
   b) FC/FS=<0.6, warm blooded source of pollution other than human.
   c) FC/FS=0.7-3.0, often indicates aging bacteria in surface waters or a mixture of both human and non-human pollutional sources.
3) References:
   a) DHEC, Division of Biological, Stream and Facilities Monitoring and Emergency Responses.
   b) Analysis by Gannett Fleming Corddry and Carpenter, Inc.
4) *: Estimated value.
5) NA = Not Applicable

TABLE II-G-12

HILTON HEAD NONPOINT SOURCE ASSESSMENT, GEOMETRIC MEANS OF FECAL COLIFORM VALUES, AUGUST 13-15, 1979 (DRY EVENT), SEPTEMBER 1-3, 1979 (WET EVENT), AND OCTOBER 17-19, 1979 (DRY EVENT).

	Fecal Coliform (MPN/100 ml) August 1979			Fecal Coliform (MPN/100 ml) September 1979			Fecal Coliform (MPN/100 ml) October 1979		
Station	High Tide	Low Tide	Combined	High Tide	Low Tide	Combined	High Tide	Low Tide	Combined
	Segment I Lawton Creek Drainage								
1	2	8	16	535	660	594	237	6	40
2	33	11	19	143	50	84	79	73	76
3	39	185	84	1,066	539	758	178	130	153
4	18	67	34	158	476	306	128	102	114
5	4	281	161	13	632	133	6	314	45
6	124	110	116	798	442	594	153	50	88
9	2	5	3	4	17	10	2	37	9
12	8	11	9	22	17	20	32	18	24
13	39	11	21	77	62	70	22	51	33
16 (Effluent)	2	2	2	2	4	3	2	2	2
19	-	-	-	-	-	-	2	7	4
	Segment II Baynard Creek Drainage								
7	10	73	27	6,176	2,384	3,836	93	180	130
8	13	246	56	281	457	376	93	409	195
11	22	22	22	1,007	898	95	385	180	264
17	33	23	28	598	796	690	417	203	291
18	7	8	9	548	311	412	24	24	24
10	3	70	13	4	115	31	4	70	16
	Segment III Point Comfort Creek Drainage								
14	2	41	9	8	38	20	3	242	25
15	21	140	54	26	142	60	16	461	86

Reference: DHEC 1979. Hilton Head, South Carolina Nonpoint Source Assessment, Interim Report No. 1. November 1979, and Interim Report No. 2 January 1980. DHEC, Division of Biological, Stream and Facilities Monitoring and Emergency Response.

sampling. This implies that contaminated waters are being drawn downstream from the upper reaches of the Lawton Creek watershed as flushing takes place at low tide, and/or adequate dilution by pollution free waters from Calibogue Sound is taking place at high tide. This was not as readily observable during the October dry weather sampling, although at Station #5 the same fluctuations were observed once again suggesting that polluted waters are being flushed from Lawton Creek into the shellfish waters of Broad Creek. There was a profound increase in bacterial levels, the rainy period bacterial concentrations tending to be an order of magnitude greater than dry season levels. During the September rainy event, all stations initially exhibited very high bacterial concentrations which became successively smaller with time (Table II-G-2). This may indicate that at the outset of a rainy event, polluted materials are flushed enmasse via surface run-off and/or the groundwater into the Lawton Canal drainage system. With each succeeding tidal flux these materials are diluted and carried out into Broad Creek/Calibogue Sound. Stations #5 and #9 exhibited significantly higher concentrations of bacteria at low tide further substantiating the premise that polluted waters are being flushed from Lawton Creek into Broad Creek.

During the dry sampling of August fecal streptococcus counts were so low that fecal coliform/fecal streptococcus ratios were often not applicable in determining whether pollution was human or non-human in origin. Where applicable most ratios were very low indicating that most pollution was non-human in origin. Most bacterial ratios from the October dry event were not only applicable but extremely low indicating non-human pollution. Because these ratios were computed from samples collected during a dry event, their validity is somewhat questionable. As previously explained in Chapter II-F, the use of fecal coliform/fecal strep ratios for analysis of the origin of non-point pollution is most accurate if sampling is conducted within 24 hours after rainfall or after the pollutional source has entered the surface waters. After this period of time, the diffusing and mixing of waters from different origins and the die-off of bacteria can result in misleading interpretations of these ratios.

During the September rainy event there was no strong indication of human pollution although many more of the fecal coliform/fecal streptococcus ratios fell into the "gray" area (0.7-3.0) indicating aging bacteria in the surface waters and/or a mixture of both human and non-human polluiona sources, (i.e. estuarine waters brought in by the tides and/or the freshwaters of Lawton Creek), Table II-G-10).

If pollution in the Lawton Creek Drainage is primarily non-human in origin it would imply that the increased bacterial levels in Lawton Creek watershed originate from detrital materials being washed after rainfall from the land into surface waters and/or dissolved and percolated into the shallow groundwater aquifer which in turn feeds and contributes to the pollution found in the surface waters. This material, in or on which the bacteria grow, would appear to be vegetational or animal (such as feces from dogs, cats, horses or wildlife) in origin. If on the other hand pollution is primarily human in origin, it would indicate faulty septic tanks and/or sewer lines contaminating the local groundwater and in turn the surface waters. Rainfall would help to flush and dilute this contaminated groundwater directly or via storm sewers into the local surface waters. If in fact pollution is from septic tanks, this could account for the observed ratios of the wet season. Being stored for some time in the groundwater, the aging fecal coliform/fecal strep ratios would change as a result of differential die-off rates. Upon being diluted and flushed into the surface waters during rainfall events and upon further mixing with surface waters and surface run-off containing bacteria of non-human origins, ratios similar to those seen in the September wet event sampling could be seen. This is highly speculative at best and will require additional sampling closer to the sources of non-point pollution (i.e. groundwater around septic tanks, run-off from gardens and horse stables, storm sewers) before firm conclusions can be drawn.

For the purpose of determining whether state standards or federal criteria are being met, results from the two dry period sampling runs (August and October 1979) were lumped providing 6 to 12 data per statistical manipulation. During the combined high tide cycles, the only sites to meet the bacterial standard for Class SA waters and approved shellfish waters (bacterial counts shall not exceed a median MPN of 70/100 ml) were the effluent (Station #16), Station #1 (above the effluent discharge), and Station #9 (on boundary between areas open and closed to shellfishing), (Table II-G-5). During the combined low tides, only the effluent met these bacterial standards from dry period data. When both low and high tide data from the two dry weather events were combined (see far right hand column, Table II-G-5), only the effluent and Station #9 met the bacterial standard for Class SA waters and Approved Shellfish waters.

Although only 3 sets of data are available for high and for low tides during the wet sampling of September (Table II-G-5) certain qualitative observations can be drawn. Only at Station #5 (the mouth of Lawton Creek as it enters Broad Creek) at high tide, the effluent (Station #16) at high and low tides, and Station #9 at low tide was the median coliform standard met for Class SA waters and Approved Shellfish waters.

A second bacterial standard exists for South Carolina Class SA waters - not more than 10% of the samples exceed a total coliform MPN of 230/100 ml. Under the combined dry season events only Station #5 met this standard at high tide while not one station met it during low tide (Table II-G-8). By combining data from both tides in order to provide a more valid statistical analysis by increasing the number of data points, no stations met the standard during the dry events. During the wet event of September only Stations #5, #9 and #16 met this standard during high tide, while only #9 and #16 met it during low tide and when high and low tide data were combined.

In the Lawton Creek Drainage area, there also are widespread violations of the U. S. Food and Drug Administration (FDA) criteria for shellfish waters - median fecal coliform counts shall not exceed 14 MPN/100 ml with no more than 10 percent of the samples exceeding 43 MPN/100 ml. During the combined dry season data only Stations #5, #9 and #16 during high tide, #16 during low tide, and #9 and #16 during combined tides met the median criteria (Table II-G-5). The second criteria was met only by Stations #5, #9 and #16 at high tide, #12 and #16 at low tide and when the tides are combined (Table II-G-8). During the wet season the median criteria for fecal coliforms was met only at Stations #9 and #16 at high tide, #16 at low tide, and #9 and #16 when both tides were combined (Table II-G-5). The second criteria was met only at stations #5, #9 and #16 at high tide, #12 and #16 at low tide, and #16 when tides were combined (Table II-G-8).

It should be noted that in the Lawton Creek watershed SB bacterial standards were violated at Stations #1 through #6 during rainy events (Table II-G-12). This indicates these waters are unfit for swimming during this climatic regime. This is a moot point as it is doubtful that these waters are used for swimming. The important point to be made is bacterial levels cannot even meet State standards for the Class SB waters which are less stringent than Class SA shellfish water standards.

In summary, the waters of Lawton Creek surpass bacterial standards and criteria established for tidal waters to assure shellfish which are safe for human consumption. Only the effluent from the Sea Pines Wastewater Treatment Plant (the only point source discharge in the study area) meets these standards and criteria with any consistency. Station #5 at the mouth of Lawton Creek and more or less centered in the area closed to shellfishing usually meets these bacterial standards and criteria at high tide. At low tide as the polluted waters of Lawton Creek Drainage are drawn past Station #5, these waters are grossly violated. Bacterial pollution is obviously non-point in origin. At present, it is difficult with the limited surface water quality data to draw firm conclusions as to whether pollution is human or non-human in origin.

Baynard Creek Drainage - Bacteria

During the dry season sampling events of August and October, there was a tendency for bacterial concentrations to fluctuate in a manner similar to the Lawton Creek Stations for the same time periods. That is, there was a tendency for low tide bacterial levels to be significantly higher than high tide values (Tables II-G-3 and 6). This would imply that polluted waters are originating upstream and being drawn past the various sampling stations at low tide, and/or adequate dilution by pollution free waters from Calibogue Sound is taking place at high tide.

During the September wet event sampling bacterial counts became successively smaller with time (Table II-G-3) as did Lawton Creek for the same period. It would appear that a large amount of polluted materials entered Baynard Creek Drainage area and after two high tides sufficient dilution had taken place to greatly reduce bacterial concentrations.

During the dry events, fecal coliform/fecal strep ratios that were applicable did not indicate human pollution (Tables II-G-8 and 11). As explained under the Lawton Creek discussion, the validity of these ratios during the dry events is questionable. In the September wet event sampling, more ratios fell into the uninterpretable "gray" area (FC/FS = 0.7 - 3.0) and a few ratios indicated possible human pollution (Table II-G-10). As in the Lawton Creek Drainage System, until non-point sources can be better delineated and sampled, no firm conclusions can be drawn as to the origin of pollution.

With the exception of Station #10 at high tide (Tables II-G-6 and 8), there is a general tendency for all stations to exceed state standards and federal criteria for shellfish waters. Only Station #10 during both wet and dry events meets swimming water standards (Class SB Waters), (Table II-G-12).

Point Comfort Creek Drainage - Bacteria

During the wet and dry sampling periods bacterial levels were highest at low tide suggesting that polluted waters are being drawn past the stations from upstream by the receding tides (Table II-G-4) and/or adequate dilution was occurring at high tide by pollution free water of

Calibogue Sound. At this time, it is difficult to draw firm conclusions about the origin of pollution based upon the widely fluctuating fecal coliform/fecal strep ratios (Tables II-G-9, 10 and 11). During the combined dry season events, state standards and federal criteria for bacteria are met during high tide but not low tide (Tables II-G-7 and 8). During the September wet season event only Station #14 at high tide meets both federal and state requirements for shellfish waters (Tables II-G-7 and 8). During the October 1979 sampling period, these waters failed to meet state bacterial standards for swimming during low tide, (Table II-G-12).

SUMMARY - BACTERIA

The preliminary DHEC sampling indicates that state standards and federal criteria for shellfish waters are violated in the Lawton Creek, Baynard Creek, and Point Comfort Creek Drainage Systems. While concentrations of bacteria in the Sea Pines wastewater treatment plant effluent remain consistantly low, bacterial levels in the surface waters increase with rainfall events and tend to increase from high to low tide. These fluctuations would point to non-point pollution originating in the interior of Hilton Head Island and draining into the shellfish waters of Broad Creek.

With the exception of the Sea Pines effluent, all water quality samples were collected in surface waters after mixing would have taken place with any non-point pollutant source. As a result, it is difficult using fecal coliform/fecal strep ratios to determine whether pollution is human or non-human in origin.

Heavy Metals

Recent environmental research suggests that bivalves may be valuable as sentinel organisms for indicating pollutants in coastal marine waters. These filter feeders have been found to bioaccumulate various marine pollutants. This has previously been seen around Hilton Head in the closure of the oyster beds of *Crassostrea virginica* on Broad Creek after routine sampling by DHEC found higher than normal levels of fecal coliform bacteria. Oysters are also known to accumulate heavy metals in their tissues. Surface water samples collected by DHEC during the August dry event and the September wet event were analyzed for mercury, lead and zinc (Table II-G-13). Additionally oyster tissues collected from Stations #5 and #9 during August were analyzed for these same metals (Table II-G-14).

Mercury (Hg). To provide protection of marine aquatic life the USEPA criteria suggests that mercury concentrations in surface waters should not exceed 0.10 ug/l. Because of the analytical sensitivity, many of the very low mercury concentrations in surface waters around Hilton Head could not be recorded with an accuracy of less than 0.2 ug/l. In a large number of cases it is therefore very difficult to determine if this criterion is being met. With the exception of Station #1, all stations surpass this criterion at least once (Table II-G-13). If anything, mercury levels appear to be slightly higher during the dry events.

TABLE II-G-13
HILTON HEAD NONPOINT SOURCE ASSESSMENT
LEAD, MERCURY, ZINC - ug/1

			SEGMENT I	SEGMENT II			
			Station 1	Station 7	Station 10	Station 17	Station 18
DRY EVENT Aug. 13 - 15, 1979	Low(2nd)	Pb	<50	490	580	570	190
		Hg	<0.2	0.4	0.3	0.4	0.3
		Zn	100	100	100	100	<100
	High(2nd)	Pb	-	-	590	-	-
		Hg			0.2		
		Zn			<100		
	Low(3rd)	Pb	<50	550	550	540	200
		Hg	0.2	1.7	<0.2	0.3	0.2
		Zn	<100	200	200	<100	200
RAIN EVENT September 1 - 3, 1979	High(1st)	Pb	-	220	-	50	210
		Hg		<0.2		<0.2	<0.2
		Zn		100		<100	100
	Low(1st)	Pb	60	70	470	60	160
		Hg	<0.2	0.3	<0.2	<0.2	<0.2
		Zn	3000	<100	200	200	3000
	High(2nd)	Pb	<50	60	560	<50	-
		Hg	<0.2	<0.2	<0.2	<0.2	<0.2
		Zn	100	100	<100	<100	-
	Low(3rd)	Pb	150	120	510	-	150
		Hg	<0.2	<0.2	<0.2		<0.2
		Zn	100	<100	100		400
DRY EVENT Oct. 17, 1979	Low(2nd)	Pb	<50	320	270	90	260
		Hg	<0.2	0.7	0.4	0.7	<0.2
		Zn	<100	100	600	<100	<100
	Low(3rd)	Pb	<50	330	650	<50	210
		Hg	<0.2	<0.2	0.2	<0.2	<0.2
		Zn	<100	<100	100	<100	200

TABLE II-G-14
HEAVY METALS ANALYSIS OF OYSTER TISSUES FROM DHEC SAMPLING STATIONS HILTON HEAD ISLAND, SOUTH CAROLINA, AUGUST 1979

Station	Mercury (Hg)		Zinc (Zn)		Lead (Pb)	
	Wet μg/100g(1)	Dry μg/g(2)	Wet μg/100g(1)	Dry μg/g(2)	Wet μg/100g(1)	Dry μg/g(2)
5	<50	<3.75	1.74×10^4	1305.00	8.6	0.65
9	<50	<3.75	1.26×10^4	945.00	1.27	0.10

(1) Values are μg of heavy metal per 100 grams of oyster tissue wet weight

(2) a) For comparison of DHEC figures converted to dry weight using a wet-weight/dry-weight ratio of 7.5, (That is wet weight concentration times 7.5 = dry weight concentration) based upon Goldberg, E. D. et al 1978. The Mussel Watch Environmental Conservation.5(2):101-125.

b) Convert μg/100g wet-weight to μg/g dry-weight for comparison to the literature.

c) μg/g = ppm

The U. S. Food and Drug Administration (1979) Action Level guideline states that mercury in edible fish and shellfish should not exceed 1.0 mg/kg (ug/g) wet weight or 7.5 (ug/g) dry weight. Mercury levels in the oysters were below this Action Level at both stations (Table II-G-14).

Lead. At present, due to insufficient data, the USEPA Red Book contains no marine criterion to protect aquatic life. Calabrese et al (1973) found a 48-hour LC_{50} of 1730 ug/l for the oyster, Crassostrea virginica, and 2450 ug/l for their eggs. Pringle, et al (1968) found that oysters, Crassostrea virginica exposed to lead concentrations of 100 and 200 ug/l for 49 days were able to concentrate the lead in their tissues to 563 and 1500 ug/g (dry weight) respectively. Additionally, they exhibited sublethal effects such as atrophy of gonadal tissue, edema and less distinction of the hepatopancreas and mantle edge. The surface water concentrations of lead at the various stations often exceeded the sublethal concentrations (Table II-G-13), although the tissue concentrations of the oysters never reached these levels (Table II-G-14). It must be assumed that sufficient dilution exists at Stations #5 and #9 to greatly reduce the levels of lead in the estuarine waters. It should be noted that the lead levels in tissues of Station #5 are 6.5 times higher than at Station #9. Station #5 is centered in the area closed to oyster harvesting and closest to the interior waters of Hilton Head Island which exhibit the high lead concentrations. Tissue levels of lead at Station #9 fall very close to the 0.2 and <0.1 ug/g concentrations respectively recorded of oysters collected from the Savannah River, Georgia and Charleston, South Carolina in the Mussel Watch Program (Goldberg et al 1978). The elevated tissue levels at Station #5 might then be considered higher than normal for the area and could be indicative of lead pollution originating from Hilton Head Island.

The USEPA Blue Book suggests that concentrations of lead in the marine environment greater than or equal to 0.05 mg/l could be hazardous to aquatic life. Concentrations less than 0.01 mg/l pose a minimal risk to aquatic life, although efforts should be made to reduce these levels even further in oyster growing areas. All stations sampled in August equal or surpass the concentration of lead considered hazardous to marine aquatic life.

At present the FDA is performing research to establish guidelines for lead levels in food in regards to human consumption (FDA 1979).

Zinc. The USEPA suggests that zinc concentrations in the marine environment not exceed (0.01) X 96 hr LC-50 of the most sensitive species. The USEPA Blue Book suggests this be lowered by an order of magnitude (0.001 multiplication factor) in the presence of other heavy metals that may act synergistically. In general, the Blue Book suggests that concentrations greater than or equal to 100 ug/l could be hazardous to marine aquatic life while concentrations less than 20 ug/l are a minimal risk. In most cases the concentrations of zinc from the sampled stations around Hilton Head equal to or exceed the levels considered hazardous for marine aquatic life (Table II-G-13).

Tissue concentrations of zinc in the oyster, Crassostrea virginica were found higher than normal around the Savannah River and Charleston stations (2660 and 4060 ug/g, respectively) in the Mussel Watch Survey (Goldberg et al 1978). Insufficient data exist to determine if these tissue levels reveal natural estuarine levels or pollution. Tissue levels from the two stations around Hilton Head were lower than the above values (Table II-G-14). The tissue levels collected by DHEC at Hilton Head were on the same order of magnitude as tissue levels of oysters taken from Skull Creek (averaging 1275 ug/g dry wt.), Broad and Jarvis Creeks (averaging 2100 ug/g dry wt.) collected in 1964-1965 (Kopfler and Mayer 1969). Therefore, zinc levels in oysters have not increased significantly since that time.

FDA guidelines do not presently exist for the levels of zinc in consumable fish flesh (FDA 1979).

Pesticides and Herbicides

Selected surface water samples collected by DHEC during August (dry event), September (wet event) and October (dry event) were analyzed for various pesticides and herbicides (Table II-G-15).

TABLE II-G-15
HILTON HEAD NONPOINT SOURCE ASSESSMENT
ORGANICS - µg/1

Station 1	Tide	Chlorinated Hydrocarbons	Organo-phos-phates(except Malathion)	Malathion	Herbicides		
					2, 4-D	2, 4, 5-T	2, 4, 5-TP
1) DRY EVENT	Low(2nd)	<0.05	<0.1	<0.1	<0.05	<0.025	<0.025
	Low(3rd)	<0.05	<0.1	<0.1	<0.05	<0.025	<0.025
2) RAIN EVENT	Low(1st)	<0.05	<0.1	1.0	<0.05	<0.025	<0.025
	High(2nd)	<0.05	<0.1	0.6	<0.05	<0.025	<0.025
3) DRY EVENT	Low(3rd)	<0.05	<0.10	<0.10	<0.05	<0.025	<0.025
Station 7							
1) DRY EVENT	Low(2nd)	<0.05	<0.1	<0.1	-	-	-
	Low(3rd)	<0.05	<0.1	<0.1	<0.05	<0.025	<0.025
2) RAIN EVENT	High(1st)	<0.05	<0.1	1.6	<0.05	<0.025	0.029
	Low(1st)	<0.05	<0.1	1.8	Trace	<0.025	0.048
3) DRY EVENT	Low(3rd)	<0.05	<0.10	<0.10	<0.05	<0.025	<0.025
Station 17							
1) DRY EVENT	Low(2nd)	-	-	-	<0.05	<0.025	<0.025
	Low(3rd)	-	-	-	<0.05	<0.025	<0.025
2) RAIN EVENT	High(1st)	<0.05*	<0.1	4.7	0.18	<0.025	0.11
	Low(1st)	<0.05	<0.1	1.9	0.038	<0.025	0.028
3) DRY EVENT	Low(3rd)	<0.05	<0.10	<0.10	<0.05	<0.025	<0.025

1) Dry Event - August 13-15, 1979
2) Rain Event- September 1-3, 1979
3) Dry Event - October 17-19, 1979

* Lindane reported at a detection level of 0.05 µg/1

Chlorinated Hydrocarbons. These pesticides which include DDT, DDD, DDE, aldrin, dieldrin, endrin and chlordane are considered very hazardous because of their persistence and accumulation in aquatic organisms. USEPA criteria are contained in Table II-G-16. DDT in seawater at 0.1 mg/l halted growth of eastern oysters *Crassostrea virginica* and dosages as low as 0.0001 ug/l significantly reduced oyster growth (Butler 1966). Eastern oysters that had bioaccumulated 151 mg/l DDT required three months in clean water to lose 95 percent of the DDT load. Growth returned to normal after 10 days of flushing in clean water (Butler 1966a). The eastern oyster exposed to 1.0 ug/l DDT in flowing sea water for 7 days and then placed in clean water showed the following tissue residues (Butler 1966a).

DDT Tissue Residue (mg/l).	After 7 Days	After 15 Days	After 30 Days
	26	2.5	1.0

Eastern oysters exposed to flowing seawater for 40 days containing 1 ug/l DDT concentrated the DDT to 70,000 times the level in the water (Butler 1964).

Eastern oysters exposed to 18 to 10 ug/l chlorodane in flowing seawater for 10 days concentrated this pesticide in their tissues to 7300 times the ambient concentration (Wilson 1965). Eastern oysters exposed to flowing seawater for 10 days containing dieldrin at 1 ug/l concentrated this pesticide 1000 times (1 mg/l) in their tissues (Wilson 1956). Wilson (1965) found the same concentration ratio of endrin by the eastern oyster. Oysters

TABLE II-G-16
USEPA ORGANO CHLORINE CRITERIA FOR PROTECTION OF MARINE LIFE

Pesticide	Criterion* µg/l
ALDRIN/DIELDRIN	0.003
CHLORDANE	0.004
DDT	0.001
ENDOSOLFAN	0.001
ENDRIN	0.004
HEPTACLOR	0.001
LINDANE	0.004
MALATHION	0.1
METHOXYCHLOR	0.03
MIREX	0.001
TOXAPHENE	0.005

*Not to be exceeded in water samples from the marine environment

Reference: USEPA. 1976. Quality Criteria for Water USEPA, Washington, D. C.

exposed for 10 days in flowing seawater concentrated lindane 60 times in their tissues, from 0.05 mg/l to 3 mg/l. Lindane at 0.3 - 0.4 ug/l killed or immobilized 50 percent of the brown and pink shrimp exposed for 48 hours (Butler and Springer 1963).

The concentrations of the chlorinated hydrocarbons are quite low from around Hilton Head Island, most being on the limits of detection by the laboratory technique employed by DHEC. The point that should be noted is that even at low concentrations filter feeders, such as the eastern oyster, can bioaccumulate persistent chlorinated hydrocarbon pesticides in their tissues. Potential sublethal effects from long term exposure to low concentrations of pesticides include inhibited shell growth, tissue atrophy and decreased fecundity. In turn, consumption of contaminated oysters or other shellfish by man could have public health implications. The 6th National Shellfish Sanitation Workshop has established limits for pesticide levels in shellfish for public health reasons (Table II-G-17). More recently the FDA has established Action Levels (Table II-G-18). No tissue analyses of oysters for pesticides was conducted by DHEC.

Organophosphates. The stability of organic phosphorous insecticides on water is pH dependent. The half-life of malathion, for instance, was reduced from about six months at a pH of 6 to one or two weeks at a pH of 8. DHEC experts found the half-life of malathion in Hilton Head waters to be approximately two weeks (USEPA Redbook). With the exception of malathion, organophosphates were at the detection limit of the instrumentation used by DHEC. Malathion concentrations did increase during the wet event suggesting surface run-off from Hilton Head Island contaminating the surrounding surface waters. The USEPA Red Book criterion for protection of freshwater and marine aquatic life states that malathion concentrations in surface waters should not exceed 0.1 ug/1. This value is exceeded at all stations during rainy events (Table II-G-15). Growth of the eastern oyster was reduced 32% by 96-hour exposure to 1 mg/1 malathion (Butler 1963). The 48-hour LC_{50} for fertilized oyster eggs was 9.07 mg/1 malathion and the 14-day LC_{50} for larvae was 2.66 mg/1 malathion (Davis and Hidu 1969).

Chlorophenoxy Herbicides. Samples of water from various stations were analyzed for the herbicides of 2, 4-D; 2, 4, 5-TP (Silvex) and 2, 4, 5-T (Table II-G-15). Each of these compounds is available in a variety of salts and esters which have different toxicities in the aquatic environment. A 48-hour total lethal mortality (TLM) concentration of 0.600 ug/1 (2,4, 5-T) 2, 4, 5-Trichlorophenol for the eastern oyster in sea water was recorded by Davis and Hidu (1969). The exposure of oysters to 2.0 mg/1 of 2, 4, 5-T acid had no effect on shell growth after 96 hours (Butler 1963). A 14-day TLM concentration of 710 ug/1 silvex for the eastern oyster in sea water was recorded by Davis and Hidu (1969). The exposure of oysters to 1.0 mg/1 of silvex (ester) for 96 hours resulted in a 23 percent decrease in shell growth (Butler 1963).

TABLE II-G-17
RECOMMENDED GUIDELINES FOR PESTICIDE LEVELS IN SHELLFISH

Pesticide	Concentration in shellfish (ppm-drained weight) [b]
ALDRIN[a]	0.20
BHC	0.20
CHLORDANE	0.03
DDT)	
DDE) ANY ONE OR ALL, NOT TO EXCEED	1.50
DDD)	
DIELDRIN[a]	0.20
ENDRIN[a]	0.20
HEPTACHLOR[a]	0.20
HEPTACHLOR EPOXIDE[a]	0.20
LINDANE	0.20
METHOXYCHLOR	0.20
2, 4-D	0.50

[a] It is recommended that if the combined values obtained for Aldrin, Dieldrin, Endrin, Heptachlor, and Heptachlor Epoxide exceed 0.20 ppm, such values be considered as "alert" levels which indicate the need for increased sampling until results indicate the levels are receding. It is further recommended that when the combined values for the above five pesticides reach the 0.25 ppm level, the areas be closed until it can be demonstrated that the levels are receding.

[b] ppm = ug/g. U.S. Department of Health, Education and Welfare, Public Health Service 1968.

TABLE II-G-18

U.S. FOOD AND DRUG ADMINISTRATION ACTION[a] LEVELS FOR PESTICIDE LEVELS IN FISH AND SHELLFISH

SEPTEMBER 1, 1979

Pesticide	Concentration in Fish and Shellfish (ppm = ug/g) Per Wet Weight of Tissue
ALDRIN/DIELDRIN	0.3[b]
CHLORDANE	0.3[c]
DDT, DDE AND TDE	5.0[d]
ENDRIN	0.3
HEPTACHLOR AND HEPTACHLOR EPOXIDE	0.3
MIREX	0.1[c]
TOXAPHENE	5.0[c]

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a) Action Levels have been established to control levels of contaminants in human food and animal feed. They represent limits at or above which FDA will take legal action to remove adulterated products from the market. Where no established action level exists, FDA may take legal action against the product at the minimal detectable level of the contaminant.

b) For concentrations individually or in combination. Not additive if either pesticide is below 0.3 ppm.

c) Fish only, no level established for shellfish.

d) Any of the three pesticides below 0.2 ppm is not additive.

A 14-day TLM of 740 ug/l 2, 4-D (ester) for the eastern oyster was recorded by Davis and Hidu (1979). The exposure of the eastern oyster to 2.0 mg/l 2, 4-D (acid) for 96 hours had no effect on shell growth (Butler 1963). It would appear that even though concentrations of the above herbicides increase in surface waters around Hilton Head Island after each rain event, they are well below concentrations that are extremely toxic. It is possible that through bioaccumulation sublethal toxic effects could occur such as a decreased fecundity, decreased shell growth or tissue atrophy.

GROUNDWATER MONITORING PROGRAM

Based upon the results from the surface water sampling program, DHEC redirected their efforts to a program of groundwater sampling in order to obtain additional data regarding sources of non-point source pollution. Fifty-two groundwater monitoring wells were established in various areas of Sea Pines. Nine (9) wells were placed in the vicinity of the holding ponds at the Sea Pines PSD wastewater treatment facility and the nearby sludge disposal area. Approximately thirty (30) wells were placed in an unsewered area off of Sea Pines Drive where dense housing exists. Four (4) wells were placed in a sewered area for comparison purposes. Another four (4) wells were placed in the area of the horse stables near Lawton Creek. Three (3) existing wells on Sea Pines were used for background purposes.

Water table levels were monitored, and the direction of groundwater movement determined in the unsewered area. The direction of groundwater movement in the area of the Sea Pines holding ponds was also determined.

Samples were collected from the majority of the wells and analyzed for total coliform, fecal coliform, fecal strep, ammonia, nitrates, TKN, total phosphorous, chlorides, limited MBAS, conductivity and temperature. Although bacteria results are of prime importance, these other parameters are excellent indicators of groundwater contamination.

Groundwater monitoring of the shallow water aquifer in the unsewered area along Sea Pines Drive and the Atlantic Ocean resulted in findings of some contamination by increased chlorides, ammonia, and surfactants. One well sample did show bacteria levels of 350/100 ml of total coliform and fecal coliform. The groundwater monitoring study also determined that ammonia and chlorides have contaminated the shallow water aquifer in the vicinity of the Sea Pines treatment plant holding ponds. However, no bacteria were found in samples from wells near the ponds. Horse stables and sewered areas did not exhibit contamination of groundwater. The groundwater sampling study has been recommended to be repeated during higher population densities in the Sea Pines area.

CHAPTER II-H

GROUND WATER RESOURCES

Beaufort County is underlain by a thick sequence of water-bearing sand, clay, marl, and limestone formations that supply most of the water for rural domestic and public drinking-water supplies, and agricultural and industrial supplies. These poorly consolidated and unconsolidated sedimentary rocks range in age from Late Cretaceous to Holocene and range in thickness from less than 3,000 feet to more than 3,500 feet in southern Beaufort County.

A formation, a group of formations, or a part of a formation that contains sufficient saturated permeable material to yield sufficient quantities of water to wells and springs is called an aquifer. Ground water in quantities adequate for most domestic, public supply, and farming needs in the Lowcountry area is generally available from one or more artesian aquifers. The three most important artesian aquifers in the Lowcountry are, in order of importance: the principal artesian aquifer, the Black Mingo aquifer, and the Middendorf aquifer.

In 1976, approximately 82 percent of the estimated 7.6 billion gallons of ground water used in the Lowcountry area (Beaufort, Hampton, Colleton, and Jasper Counties) came from the principal artesian aquifer, about 5 percent came from the Middendorf aquifer, and the remaining 13 percent came from the Black Mingo aquifer.

HYDROGEOLOGIC FORMATIONS

This section will describe only those geologic formations that are the chief sources of ground water supplies in Beaufort County, and specifically on Hilton Head Island. A detailed description of the geology and stratigraphy underlying Beaufort County was presented in Chapter II-E.

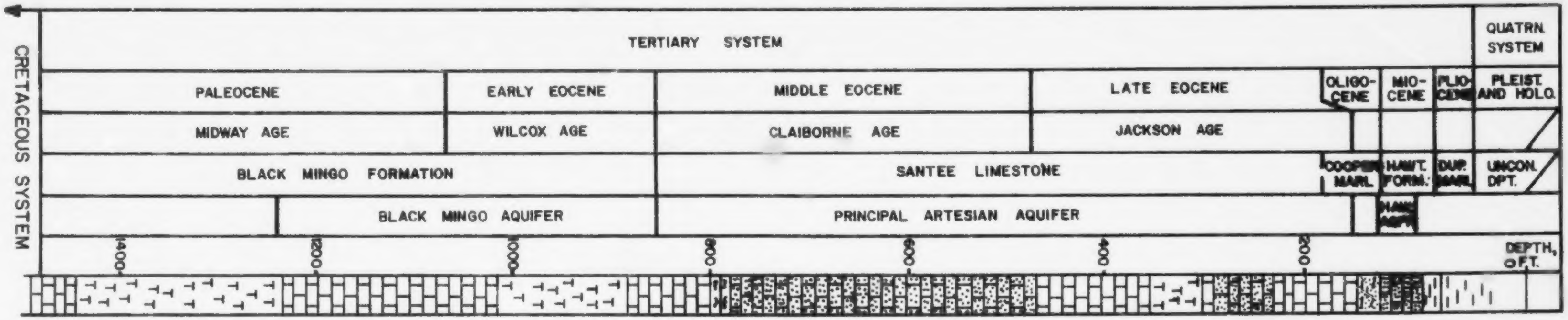
In neighboring Colleton County to the north, the upper section of the Middendorf Formation of Late Cretaceous age, consisting of medium to coarse sand and gravel, is the very productive Middendorf aquifer. Well yields of 1,200 gallons per minute (gpm) to 1,400 gpm of high quality water are common. Only four wells in Beaufort County are open to the upper part of the Middendorf Formation, and only one of these is located on Hilton Head Island (within Hilton Head Plantation, Spring Lake Recreation Area). All these wells in Beaufort County have natural flows of about 75 gpm of highly mineralized water that has a temperature of around 38°C. The top of the Middendorf aquifer occurs at a depth of 2,650 feet below msl in the Hilton Head Plantation well. The thickness of the Middendorf Formation is more than 1,200 feet in the Hilton Head Island area.

Although the Black Creek Formation and the Peedee Formation, both of Late Cretaceous age, are productive aquifers in other parts of the state, it is unlikely that they will yield significant quantities of freshwater in Beaufort County.

The Tertiary System consists, in ascending order, of the Black Mingo Formation of Paleocene and Early Eocene (Wilcox) age, the Santee Limestone of Middle and Late Eocene (Claiborne and Jackson) age, the Cooper Marl of the Late Eocene and Oligocene age, the Hawthorn Formation of Miocene age, and the Duplin Marl of Pliocene age. The tertiary formations are the chief sources of ground-water supplies in the study area. A generalized geologic section describing the lithologies of the Tertiary rocks underlying Hilton Head Island is given in Figure II-H-1.

The Black Mingo aquifer is a source of moderate quantities of good quality water in neighboring Colleton and Hampton Counties. Wells open to this aquifer in these counties have natural flows of 50 - 250 gpm at land surface. The Black Mingo aquifer consists of phosphatic, fossiliferous limestone, of sandy limestone, and of calcareous sand. In Beaufort County the Black Mingo Formation is unlikely to yield large quantities of fresh water.

The Santee Limestone is part of the principal artesian aquifer and furnishes much of the ground water used in the area. Except where saltwater contamination has taken place, the Santee Limestone is capable of yielding from 200 to more than 2,000 gpm of good quality water.


CRETACEOUS SYSTEM
TERTIARY SYSTEM
QUATRN. SYSTEM
PALEOCENE
EARLY EOCENE
MIDDLE EOCENE
LATE EOCENE
OLIGO-CENE
MIO-CENE
PLIO-CENE
PLEIST. AND HOLO.
MIDWAY AGE
WILCOX AGE
CLAIBORNE AGE
JACKSON AGE
BLACK MINGO FORMATION
SANTEE LIMESTONE
COOPER MARL
HAWT. FORM.
DUP. MARL
UNCON. DPT.
BLACK MINGO AQUIFER
PRINCIPAL ARTESIAN AQUIFER
DEPTH, FT.
0
200
400
600
800
1000
1200
1400

SOURCE SCWRC, 1979, REPORT NUMBER 9, "THE GROUND-WATER RESOURCES OF BEAUFORT, COLLETON, HAMPTON, AND JASPER COUNTIES, SOUTH CAROLINA."

LEGEND

☐ SAND
▦ LIMESTONE
▤ CLAY
▩ SANDY LIMESTONE
TTT CALCAREOUS SAND
▧ SANDY CLAY
▥ CLAYEY SAND

SOURCE OF DATA – USGS/SCWRC

GAMMA LOG 0-320 FT.	BFT454(a)
DO 320-TD	BFT454(a)
ELECTRIC LOG	BFT454(a)
LITHOLOGIC LOG	BFT454(a)

(a) LOCATION OF WELL BFT454 SHOWN ON PLATE III-I-1.

GENERALIZED GEOLOGIC SECTION OF TERTIARY SYSTEM

FIGURE II-H-1

The top of the Santee Limestone occurs from a few feet below land surface to more than 200 feet below land surface. The total thickness of the formation is more than 900 feet in Beaufort County.

The Cooper Marl varies from a very-sandy, calcareous, slightly- to moderately- phosphatic clay to a silty, sandy phosphatic, clayey limestone to a light-gray to white limestone. In much of Beaufort County the lower part of the Cooper Marl is considered to be part of the principal artesian aquifer and capable of yielding more than 200 gpm of good quality water.

Shallow aquifers occur in some areas in the Hawthorn Formation and unnamed Pleistocene deposits and are tapped by small-diameter, shallow wells used primarily for rural-domestic (private) supplies in some areas of Beaufort County; however, these shallow aquifers are relatively thin, laterally discontinuous, and relatively untapped.

The upper and lower sections of the Hawthorn Formation act as confining beds. The middle section of the Hawthorn is a fairly persistent, sandy, dolomitic limestone (Hawthorn aquifer) and is a source of 50 to 200 gpm of good quality water in western Beaufort County.

The water-bearing characteristics of the Pliocene to Holocene deposits are not well known. Wells tapping the Pliocene-Holocene deposits, particularly in neighboring Jasper County, are reported to yield water of acceptable quality and quantity for domestic or small agricultural and industrial needs. The yield and quality vary considerably from place to place. Water from these formations may be hard and contain high concentrations of iron and hydrogen sulfide. Near the coast or saltwater estuaries, water from these deposits may be salty.

PRINCIPAL ARTESIAN AQUIFER

Underlying Beaufort County is an artesian aquifer composed of a series of limestones ranging from Eocene to Oligocene in age. This aquifer extends into southeastern Georgia, Florida, and adjacent parts of Alabama. The aquifer is referred to as the Ocala or principal artesian aquifer in Georgia, as the Floridan aquifer in Florida, and as the principal artesian aquifer in South Carolina.

In the Lowcounty area, the principal artesian aquifer ranges in thickness from less than 400 feet to more than 1,000 feet. The uppermost section of the underlying Black Mingo Formation (which consists of fine, white to yellow sand and red to brown, sandy clay) acts as the lower confining bed. The upper Oligocene section consisting of sandy, calcareous, phosphatic clay and the lower Miocene section consisting of fine, sandy, greenish clay together act as the upper confining bed. The upper confining bed varies in thickness from zero to more than 50 feet. In parts of southern Beaufort County where the upper confining bed is absent, the Hawthorn aquifer is contiguous and hydraulically connected to the principal artesian aquifer.

Water-Yielding Zones. The principal artesian aquifer is divided into an upper permeable zone, which furnishes nearly all of the water pumped from this aquifer in Beaufort County; a middle zone of relatively low permeability, which yields small amounts of water to wells in northern Hampton and Colleton Counties; and a lower permeable zone, which provides most of the water pumped from this aquifer in Colleton County.

The upper permeable zone consists of white to light-gray calcitized, indurated, very fossiliferous limestone and varies considerably in thickness and lateral extent. It is more than 200 feet thick in southern Jasper County and western Beaufort County and thins toward the north and northeast, pinching out near the Beaufort-Colleton County line. The upper permeable zone is very thin in eastern Beaufort County over the Beaufort Arch where the top of the principal artesian aquifer is within 25 feet of land surface. Throughout Beaufort and Jasper Counties and much of Hampton County, the upper permeable zone of the principal artesian aquifer is the primary source of ground water.

The upper permeable zone is separated from the lower permeable zone by a middle zone of low permeability, consisting of a soft, sandy, clayey limestone ranging in thickness from 200 feet or less in northwestern Hampton County to more than 700 feet in southeastern Beaufort County.

The lower permeable zone consists of an indurated, siliceous, slightly-glauconitic, light-gray to creamy-yellow limestone. It ranges in thickness from less than 30 feet in parts of Beaufort County to more than 90 feet in Colleton and Hampton Counties to the north. This lower permeability zone is the primary source of ground water in most of Colleton County and in northeastern Hampton County, where the upper permeable zone is missing or is very thin; however, only eight wells in Beaufort County are known to be open to both the lower and upper permeable zones.

A map showing the top of the principal artesian aquifer underlying Hilton Head Island was constructed by the SCWRC using natural gamma radiation, electric, and lithologic logs and is shown on Plate II-H-1. The top of the principal artesian aquifer is a highly irregular surface that ranges from less than 20 feet below msl in the Beaufort Arch to more than 200 feet below msl in the Ridgeland Trough paralleling the Savannah River in the lower-most reaches. The irregular surface of the top of the principal artesian aquifer may reflect solution occurring as a result of advance and recessions of the Pleistocene Sea. During Pleistocene time when the sea level was much lower than now, the land area extended to the edge of the Continental Shelf and the upper Tertiary sediments were above sea level. At this time, solution cavities and sinkholes were probably formed in the limestone. Numerous circular depressions in the topography of the Beaufort area appear to be the result of settling of sediment-filled sinkholes.

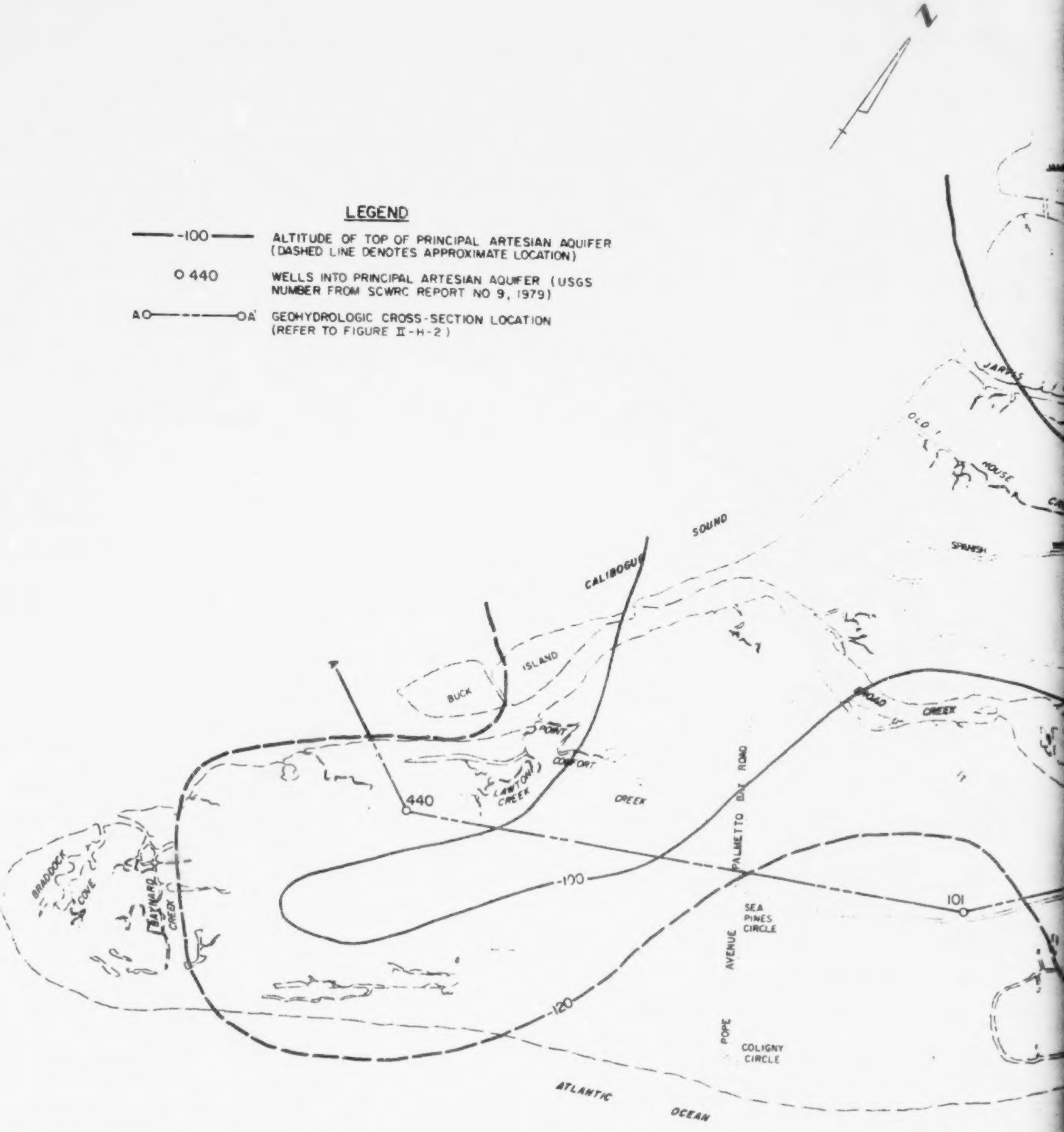
Also shown on Plate II-H-1 is the location of geohydrologic cross-section A-A' across Hilton Head Island. Figure II-H-2 is a section view of A-A' and shows the stratigraphic position of the upper permeable zone underlying Hilton Head Island.

Hydraulic Properties. The hydraulic properties of an aquifer are generally determined by field tests of discharging wells. The most common hydraulic properties determined by aquifer tests are transmissivity (T) and storage coefficients (s).

The transmissivity of an aquifer is defined as the rate at which water of the prevailing kinematic viscosity (resistance to flow) is transmitted through a unit width of the aquifer under a unit hydraulic gradient. Transmissivity is equal to the hydraulic conductivity (in units of ft/day) multiplied by the saturated thickness of the aquifer and is expressed in square feet per day. A productive aquifer has both high hydraulic conductivity and high transmissivity.

The storage coefficient is the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. The storage coefficient is dimensionless and ranges from 10^{-5} to 10^{-3} for most confined (artesian) aquifers.

The results of aquifer tests conducted in 1972 on Hilton Head Island indicated that the transmissivity of the principal artesian


N
SOUND
CALIBOGUE
BUCK
ISLAND
POINT
COMFORT
LAWTON CREEK
CREEK
440
BRADDOCK
COVE
BAYNARD CREEK
-100
-120
PALMETTO BAY ROAD
AVENUE
POPE
SEA PINES CIRCLE
COLIGNY CIRCLE
101
BROAD CREEK
JARVIS
OLD HOUSE
SPANISH
ATLANTIC OCEAN

LEGEND

—-100—	ALTITUDE OF TOP OF PRINCIPAL ARTESIAN AQUIFER (DASHED LINE DENOTES APPROXIMATE LOCATION)
○ 440	WELLS INTO PRINCIPAL ARTESIAN AQUIFER (USGS NUMBER FROM SCWRC REPORT NO 9, 1979)
A○- - - - -○A'	GEOHYDROLOGIC CROSS-SECTION LOCATION (REFER TO FIGURE II-H-2)

NOTE: DATUM IS MEAN SEA LEVEL

SOURCE: SCWRC, 1979, REPORT NO 9, "THE GROUND-WATER RESOURCES OF BEAUFORT, COLLETON, HAMPTON, AND JASPER COUNTIES, SOUTH CAROLINA"

II-H-5a

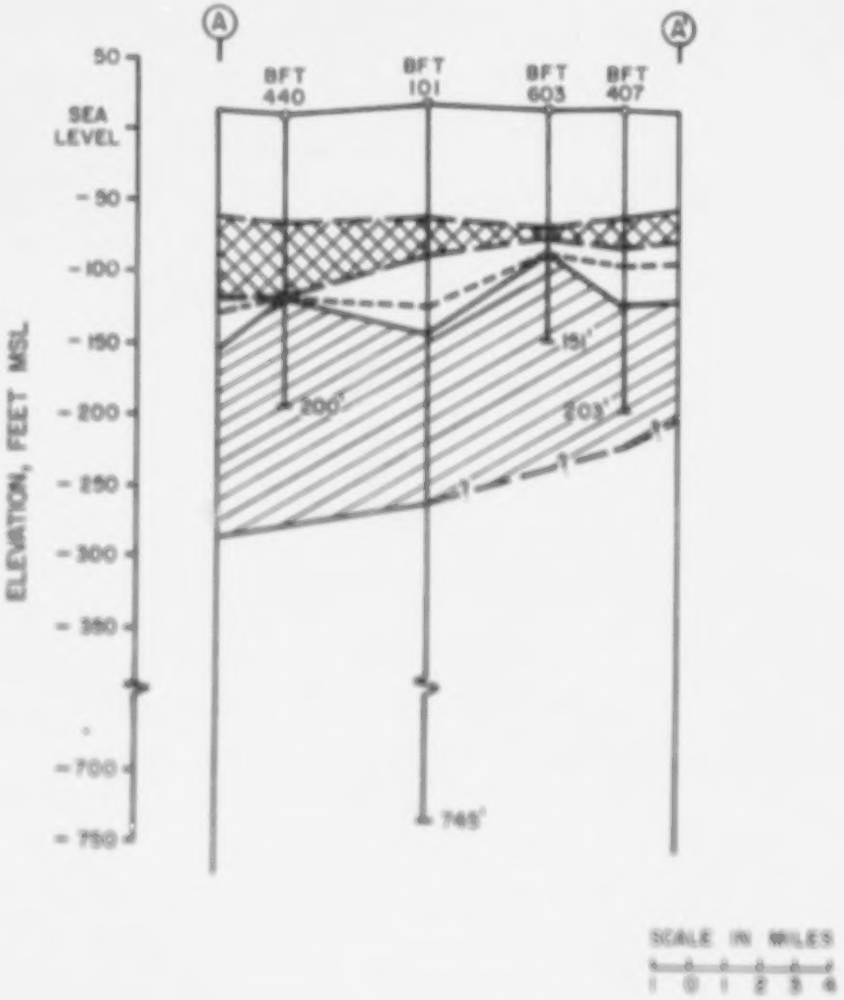
N
PINCKNEY ISLAND
SKULL CREEK
-80
-70

PLATE [illegible]

HILTON HEAD ISLAND
SOUTH CAROLINA

SURFACE CONFIGURATION
OF TOP OF PRINCIPAL
ARTESIAN AQUIFER

SCALE IN FEET


A
A'
BFT 440
BFT 101
BFT 603
BFT 407
50
SEA LEVEL
-50
-100
-150
-200
-250
-300
-350
-700
-750
ELEVATION, FEET MSL
151'
200'
203'
745'
?
SCALE IN MILES
1 0 1 2 3 4

LEGEND

▩ HAWTHORN AQUIFER

▨ UPPER PERMEABLE ZONE OF PRINCIPAL ARTESIAN AQUIFER

- - - - TOP OF PRINCIPAL ARTESIAN AQUIFER

—?—?— ESTIMATED

745' DEPTH OF WELL, FEET

SOURCE: SCWRC, 1979, REPORT NUMBER 9, "THE GROUND WATER RESOURCES OF BEAUFORT, COLLETON, HAMPTON, AND JASPER COUNTIES, SOUTH CAROLINA."

GEOHYDROLOGIC CROSS SECTION A-A'
HILTON HEAD ISLAND

aquifer ranged from 71,000 ft^2/day on the north end of the island (within Hilton Head Plantation) to 52,000 ft^2/day on the south end of the island (near Lawton Creek confluence with Broad Creek.) Storage coefficients were determined to be 3.0×10^{-4} and 3.0×10^{-3}, for the north end and south end of the island, respectively.

The transmissivity of the principal artesian aquifer varies considerably. In general, transmissivities decrease to the north and northeast and increase towards the southwest, with transmissivities ranging from less than 30,000 ft^2/day to more than 50,000 ft^2/day west of Broad River and ranging from less than 2,000 ft^2/day to 15,000 ft^2/day east of Broad River. Broad River empties into Port Royal Sound just north of Hilton Head Island.

The coefficient of storage of the principal artesian aquifer ranges from 3×10^{-5} to 3×10^{-3}. Th higher values generally occur where the overlying confining material is thin or relatively permeable, allowing leakage into the principal artesian aquifer from the overlying Hawthorn aquifer.

The average hydraulic conductivity of the upper permeable zone of the principal artesian aquifer is estimated to be 400 ft/day in western Beaufort County (west of Broad River) and 175 ft/day in eastern Beaufort County. The hydraulic conductivity of the lower permeable zone is estimated to vary between 75 and 100 ft/day in the eastern section of Beaufort County.

Yield-of-Wells. Yields of wells open to the principal artesian aquifer range from less than 50 gpm in Colleton County to more than 2,500 gpm on Hilton Head Island. The specific capacities, defined as the yield per unit of drawdown, range from about 250 gpm/ft at Hilton Head Island to about 5 gpm/ft in Colleton County to the north. Generally, many wells yield less than the maximum possible rate because the wells do not penetrate the full thickness of the aquifer.

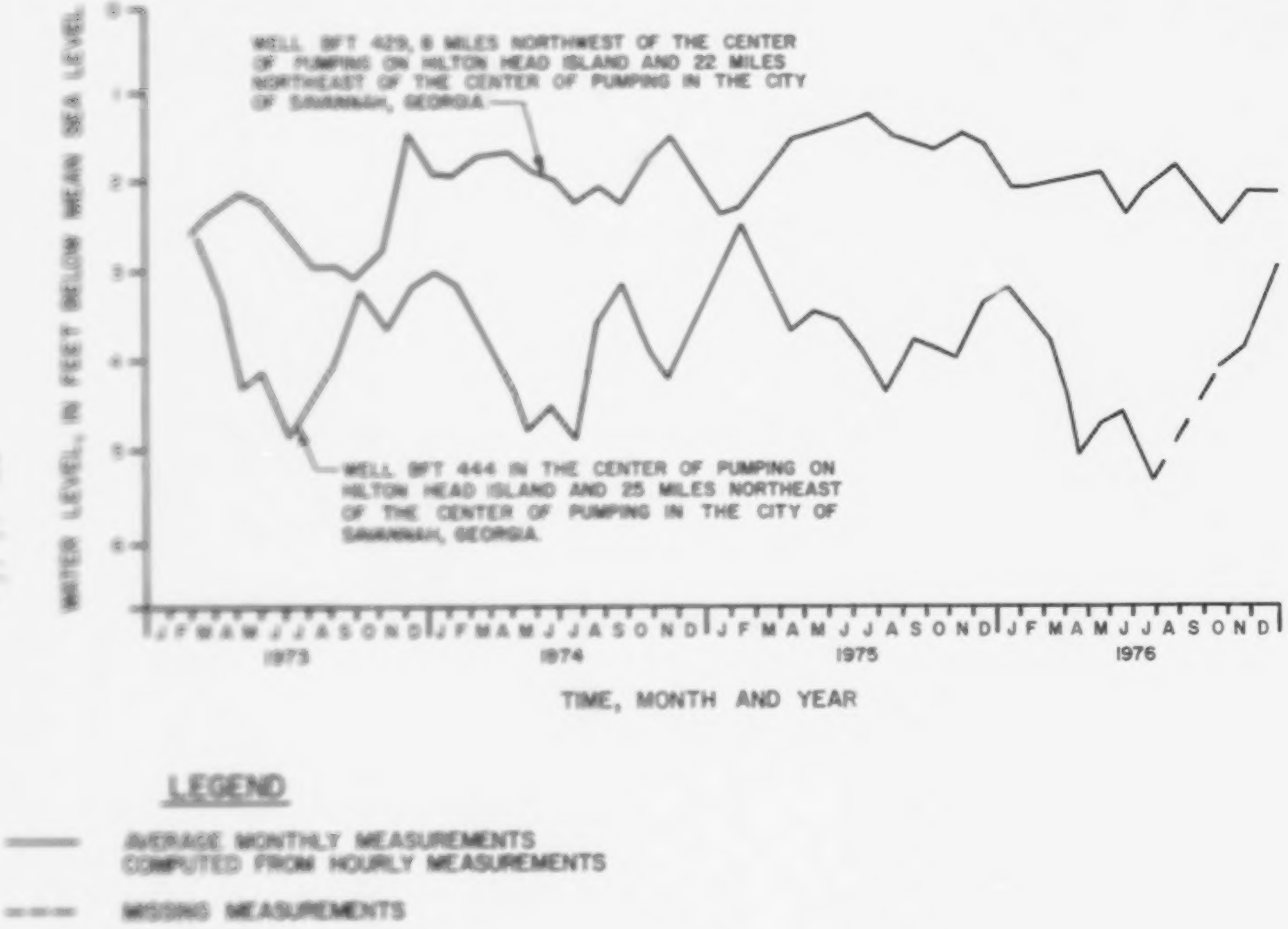
Water-Level Declines. With the withdrawal of ground water from the principal artesian aquifer by the City of Savannah, Georgia, in the 1880's, the water levels in the Savannah - Beaufort, South Carolina area began a steady decline. The City of Savannah and nearby industries currently pump about 75 to 90 million gallons per day (mgd) from the principal artesan aquifer. Since 1880, when the original water level was 35 feet above msl, water levels in the City of Savannah at the center of the cone of depression generated by the Savannah area pumpage have declined 185 fet to a level of about 150 feet below msl.

On Hilton Head Island the approximate decline of the potentiometric (piezometric) surface of the principal artesian aquifer from 1880 thru 1976 is about 10 feet in the northern third of the island, about 20 feet in the middle third of the island, and about 30 feet in the southern third of the island.

Water-Level Fluctuations. The chief agents causing water level fluctuations in the principal artesian aquifer are pumping, ocean tides, aquifer loading, and barometric pressure changes. By far the most noticeable cyclic water-level fluctuations in the Lowcountry area occur as a result of tidal oscillations. The tidal efficiencies (the ratio of the amplitude of water-level fluctuation in a well to the amplitude of the corresponding tidal oscillation in a nearby tidal body) range from less than 0.05 for wells a mile or more from tidal surface-water bodies to more than 0.75 for wells a few hundred feet or less from tidal surface-water bodies. Tidal oscillations of more than 6 feet in amplitude are common in the Beaufort area; therefore, water-level in wells may fluctuate more than 4.5 feet as a result of tidal oscillations.

The predominant cause of water-level fluctuations in wells open to the principal artesian aquifer in the Hilton Head Island area due to tidal stress is probably due to a mechanical loading or stress on the confining layer and not due so much to the hydraulic connection between the tidal body and the aquifer.

Figure II-H-3 shows the hydrographs of Hilton Head area observation wells Bft 429 and Bft 444 for the period of March, 1973 thru December, 1976. Well Bft 444 is approximately 25 miles northeast of the center of pumping at Savannah and in the center of pumping on Hilton Head Island, while well Bft 429 is approximately 22 miles northeast of the center of pumping at Savannah and 8 miles northwest of the



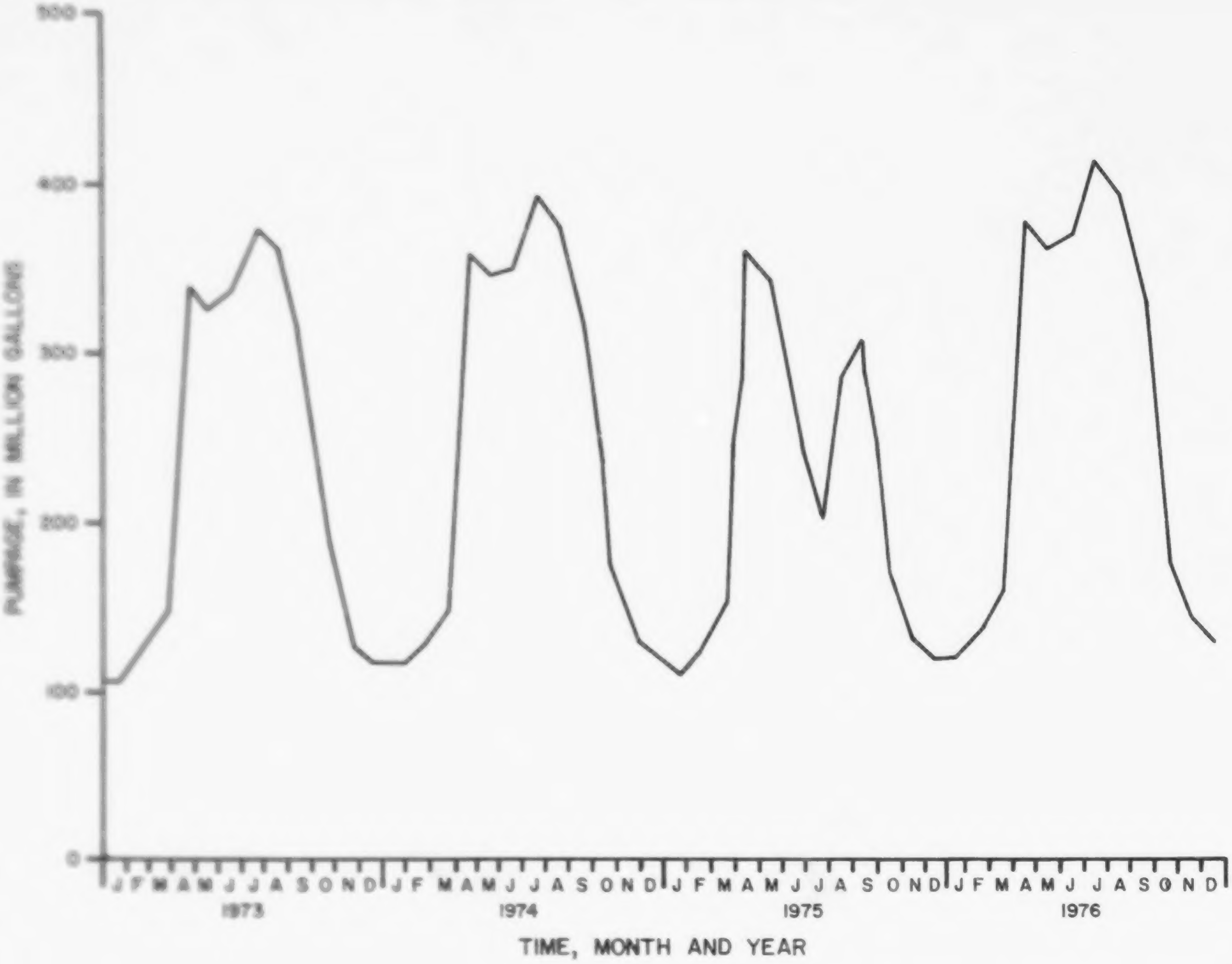
SOURCE: SCWRC, 1979, REPORT NUMBER 9,
"THE GROUND-WATER RESOURCES OF BEAUFORT, COLLETON,
HAMPTON, AND JASPER COUNTIES, SOUTH CAROLINA"

WATER-LEVEL HYDROGRAPHS
HILTON HEAD AREA WELLS (1973-1976)

center of pumping on Hilton Head Island. Plate III-I-1 shows the location of well Bft 444. The water levels were measured hourly on a continuous basis by means of automatic water-level recorders. The cyclic drawdowns in the hydrographs dramatically reflect the large pumpage at Hilton Head Island from May through September. The relatively large withdrawals during these months reflect the increased use of water for golf course irrigation because of the higher temperatures and evapotranspiration rates and also due to the heavy tourist influx.

Figure II-H-4 shows a hydrograph of estimated total monthly pumpage from the upper permeable zone of the principal artesian aquifer at Hilton Head Island for the 1973-1976 period. The high pumpage rates from May through September are quite apparent. Comparison of Figures II-H-3 and II-H-4 will show a direct relation between water levels and pumpage, particularly in observation well Bft 444 which is located in the center of pumping on Hilton Head Island.

Potentiometric Surface. The potentiometric (piezometric) surface is an imaginary surface representing the areal distribution of pressure head in an artesian aquifer. It represents the height to which water will stand in tightly cased wells open only to that particular artesian aquifer. In an artesian aquifer, ground water is always under pressure and moves from points of higher hydraulic pressure to points of lower hydraulic pressure. The potentiometric contour surface indicates the general direction of ground-water flow. Water in the aquifer moves perpendicular to the contours from high to low head levels. Pumping



SOURCE: SCWRC, 1979, REPORT NUMBER 9,
"THE GROUND-WATER RESOURCES OF BEAUFORT, COLLETON,
HAMPTON, AND JASPER COUNTIES, SOUTH CAROLINA."

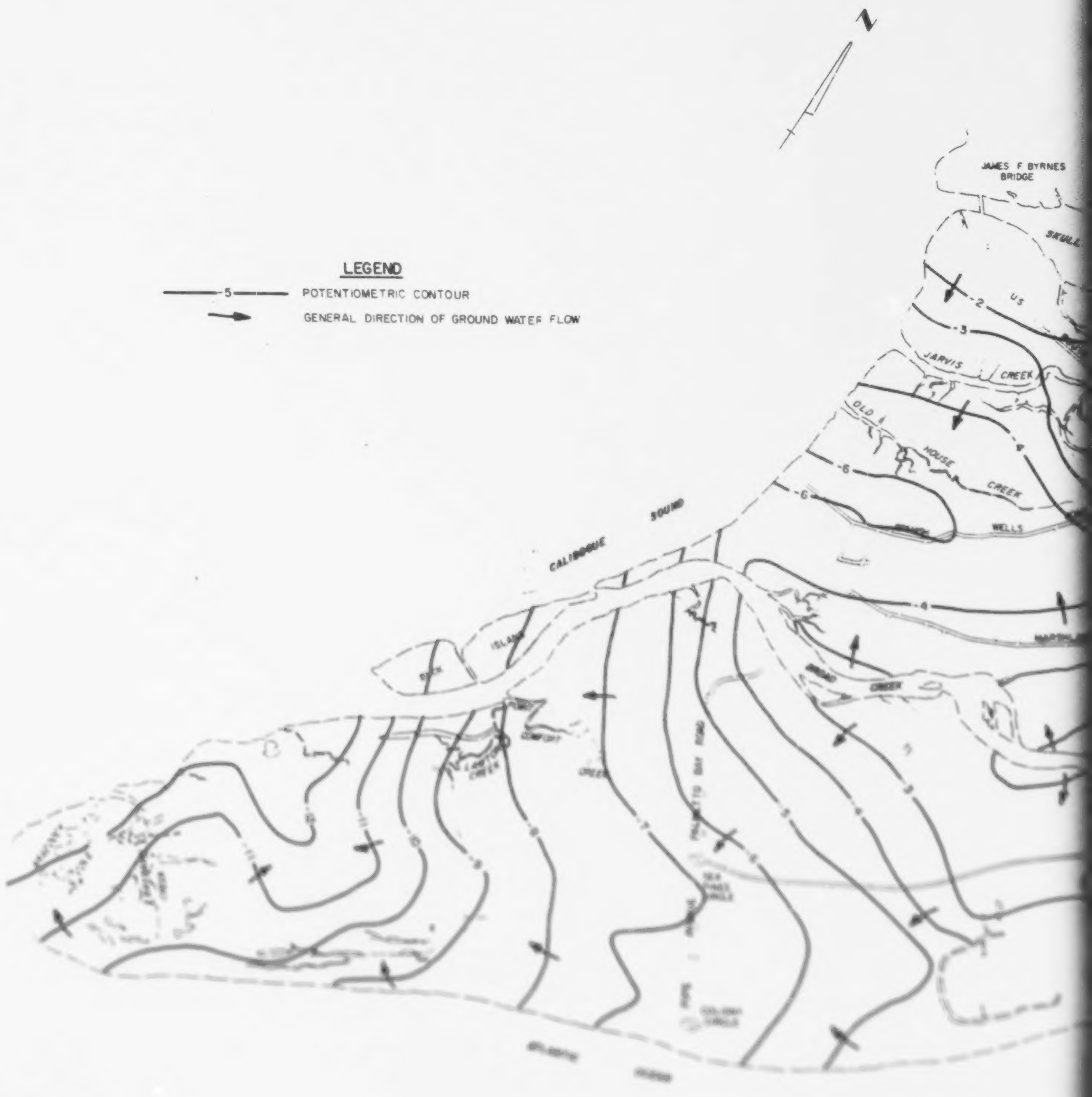
ESTIMATED TOTAL MONTHLY PUMPAGE
FROM THE UPPER PERMEABLE ZONE
HILTON HEAD ISLAND (1973-1976)

or recharge can alter the natural system by creating an artificial hydraulic gradient.

Before withdrawal of large amounts of water from the principal artesian aquifer, the potentiometric surface was controlled mainly by the hydraulic characteristics of the aquifer and the overlying and underlying confining beds, by the topography and altitude of the outcrop areas, and by natural recharge and discharge. The potentiometric map of 1880 showed an easterly hydraulic gradient of about 1 ft/mile, with natural discharge occurring in the Port Royal Sound and Parris Island area.

Since then there has been moderate to significant pumping activity at Savannah, the Burton Well Field on Port Royal Island, the U. S. Marine Corps facilities at Parris Island, and at Hilton Head Island. All of these pumping centers have contributed to creating local cones of depression, steepening of the slopes of the potentiometric surface towards local cones of depression, and increasing the size of the major cone of depression centered at Savannah.

The potentiometric surface for Hilton Head Island is shown in Plate II-H-2. The general movement of ground water is in a southwesterly direction along the major axis of the island towards the cone of depression centered at Savannah. The increase in the hydraulic gradient towards the southwest is also apparent in Plate II-H-2. There is a relative high in the very northern end of the island along Port



N
JAMES F BYRNES BRIDGE
SKULL
US
-2
-3
JARVIS CREEK
OLD HOUSE CREEK
-4
-6
-6
WELLS
CALIBOGUE SOUND
ISLAND
-6
MARSHLAND
BROAD CREEK
COMFORT
CREEK
PALMETTO BAY ROAD
SEA PINES CIRCLE
POPE AVENUE
COLIGNY CIRCLE
-12
-11
-11
-10
-9
-8
-7
-6
-5
-4
-3
ATLANTIC OCEAN

LEGEND

—5— POTENTIOMETRIC CONTOUR

→ GENERAL DIRECTION OF GROUND WATER FLOW

NOTE: DATUM IS MEAN SEA LEVEL.

SOURCE: SIPLE, [illegible] "THE GROUND-WATER RESOURCES OF BEAUFORT, COLLETON, HAMPTON AND JASPER COUNTIES, SOUTH CAROLINA"

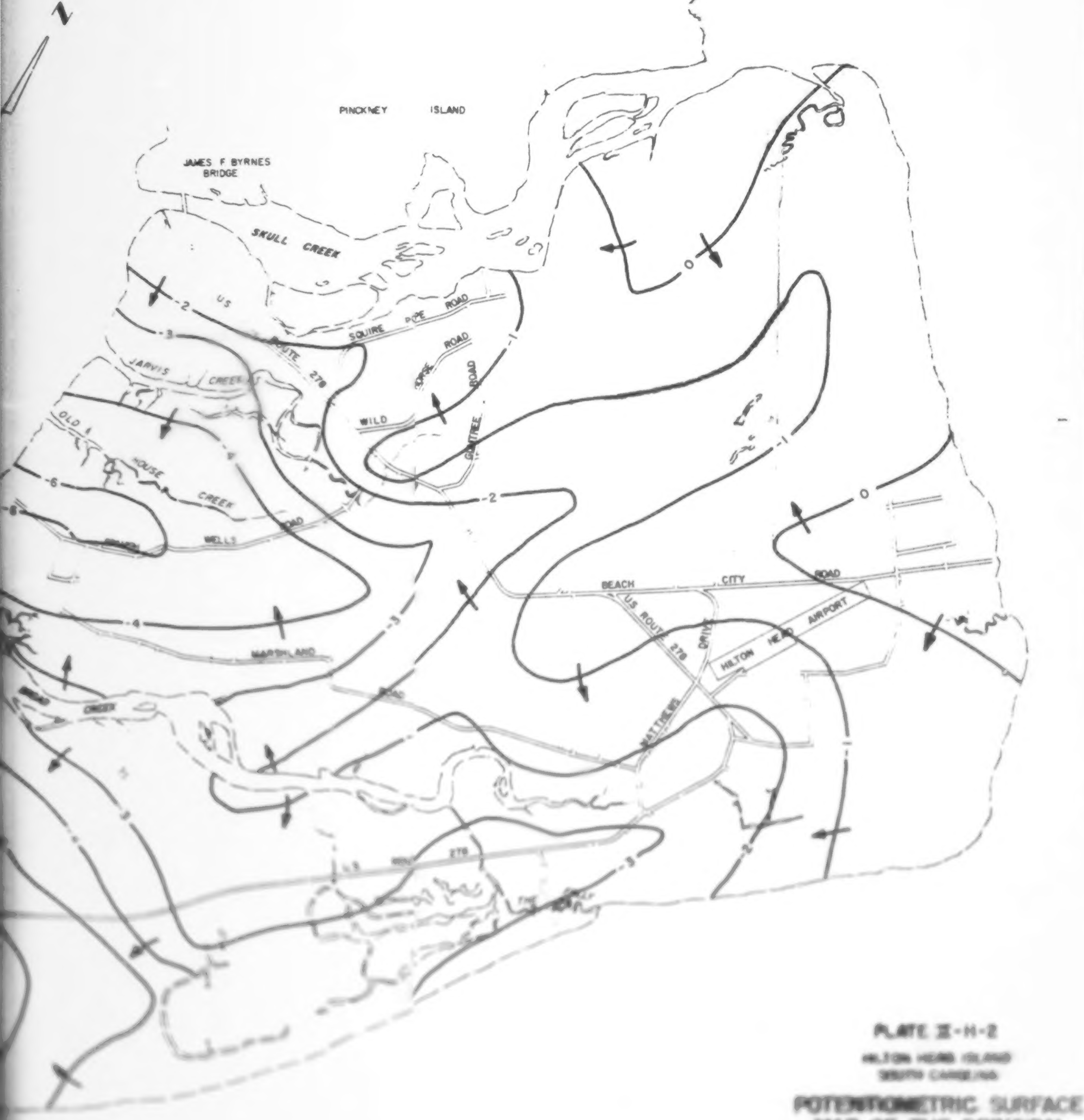

N
PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
US ROUTE 278
SQUIRE POPE ROAD
JARVIS CREEK
WILD HORSE ROAD
GUMTREE ROAD
OLD HOUSE CREEK
WELLS ROAD
BEACH CITY ROAD
US ROUTE 278
MATTHEWS DRIVE
HILTON HEAD AIRPORT
MARSHLAND
BROAD CREEK
US HWY 278
0
-1
-2
-3
-4
-5
-6

PLATE II-H-2

HILTON HEAD ISLAND
SOUTH CAROLINA

POTENTIOMETRIC SURFACE MAP OF THE PRINCIPAL ARTESIAN AQUIFER

SCALE IN FEET

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA GEORGIA

Royal Sound, possibly due to local recharge taking place through a break in the confining bed or where the confining bed is missing, or due to a large increase in its hydraulic conductivity.

Recharge. A primary source of recharge to the principal artesian aquifer in the Lowcountry area (Beaufort, Jasper, Hampton, and Colleton Counties) is precipitation falling in the outcrop area in Allendale, Bamberg, and Orangeburg Counties 60 to 80 miles north and northwest of Hilton Head Island and possibly in northwestern Hampton County. Analyses of data collected by the SCWRC for the capacity use investigation of the Lowcountry indicate that natural recharge from precipitation from the outcrop area into the four-county Lowcountry area is probably 40 to 45 mgd.

Recharge also takes place locally by vertical leakage through the overlying confining bed and in places where the confining bed is absent. Recharge to the aquifer through the confining bed is dependent upon the thickness and hydraulic conductivity of the confining bed and upon the hydraulic head differential between the water level in the principal artesian aquifer and the water level in the overlying surficial water table or Hawthorn artesian aquifer where present.

A vertical hydraulic conductivity of 1×10^{-3} feet/day for the confining bed is believed to be a reasonable average value for southern Jasper and Beaufort Counties. Natural recharge through vertical leakage is conservatively estimated to be about 500 gal/day/sg.mi., resulting in recharge to the principal artesian aquifer in the Lowcountry area in excess of 5 - 10 mgd. Most of this recharge (about 4 mgd) is taking place in the vicinity of a potentiometric high north of Beaufort which is about 40 square miles in extent.

Assuming the confining bed overlying the principal artesian aquifer at Hilton Head Island has an average hydraulic conductivity of 1×10^{-3} ft/day and an average thickness of 25 - 30 feet, and a downward hydraulic head of 1 foot exists between the water level in the principal artesian aquifer and the water level in the overlying Hawthorn aquifer or water table aquifer, then natural recharge to the principal artesian aquifer through vertical leakage in the Hilton Head Island area is about 170,000 - 210,000 gpd.

Discharge and Utilization. The principal artesian aquifer transmits water from its outcrop area or area of recharge to outlets of natural or artificial discharge. Natural discharge results from upward or downward leakage through adjacent confining beds and from leakage in areas that outcrop or are exposed in streams, estuaries, and the Atlantic Ocean floor. Some areas that once were discharge sites are now recharge sites because the hydraulic head in the principal artesian aquifer has been reduced by pumping.

Withdrawal of water through wells is an artificial stress upon a previously balanced hydrologic system and accounts for most of the ground water discharge in the area. This stress is generally concentrated in relatively small areas.

In 1976, the four-county area used an estimated 7.6 billion gallons (20.8 mgd) of ground water, with about 82 percent, or 6.2 billion gallons (17.0 mgd), coming from the principal artesian aquifer. The remaining 1.4 billion gallons (3.8 mgd) was split between the Middendorf and the Black Mingo aquifers.

Table II-H-1 shows the estimated water use from the principal artesian aquifer for Hilton Head Island and Beaufort County and the type of use in 1976. Figures for neighboring Jasper, Hampton, and Colleton Counties are included in Table II-H-1 for comparison purposes.

Beaufort County used 4,780 million gallons (13.1 mgd) of ground water from the principal artesian aquifer in 1976, which is about 77 percent of the total amount of the 6,180 million gallons (16.9 mgd) used by the four-county area. Hilton Head Island accounted for about 66 percent (8.6 mgd) of the ground water used in Beaufort County.

Ground-water use in Beaufort County is predominately concentrated in the eastern part of the county and on Hilton Head Island, with golf courses and crop irrigation accounting for over half of the ground water used in the county and about 61 percent of the ground water

TABLE II-H-1
ESTIMATED WATER USE FROM THE PRINCIPAL ARTESIAN AQUIFER FOR 1976[1]

Area	Domestic		Public Supply		Industrial		Irrigation		Stock		Total	
	mg[2]	%[3]	mg	%	mg	%	mg	%	mg	%	mg	%
Hilton Head Island	50	5	1,192	64	-	-	1,909	72	-	-	3,151	51
Beaufort County[4]	620	56	1,400	76	140	44	2,600	97	20	9	4,780	77
Colleton County	70	6	80	4	80	25	20	1	-	-	250	4
Hampton County	130	12	140	8	100	31	20	1	110	48	500	8
Jasper County	290	26	230	12	-	-	30	1	100	43	650	11
TOTAL	1,110	100	1,850	100	320	100	2,670	100	230	100	6,180	100

---

[1] Reference: SCWRC, "The Ground-Water Resources of Beaufort, Colleton, Hampton and Jasper Counties, South Carolina", Report No. 9, 1979.

[2] mg - million gallons

[3] Percent of column total for respective type of use.

[4] Beaufort County usage figures include usage on Hilton Head Island

used on Hilton Head Island. Golf course irrigation is heaviest from March through October, and crop irrigation takes place almost exclusively in the months of May, June, September, and October. Approximately 1,909 million gallons (5.2 mgd average) of ground water were used for irrigation purposes on Hilton Head Island in 1976.

The Savannah area, which includes the City of Savannah and nearby industries, pumped about 75 mgd (27 billion gallons per year) from the principal artesian aquifer in 1976. Currently this pumpage is estimated at 75 to 90 mgd.

Water Quality. The quality of ground water is highly dependent on the soluble minerals of the aquifer. Materials lying above or below the aquifer may also contribute dissolved substances. As the ground water percolates through soil and rock, it dissolves mineral matter from the rock. The amount and kind of dissolved mineral matter in ground water depends on the composition and solubility of the rocks of the aquifer and upon the length of time the water is in contact with the rock. The concentrations of dissolved substances generally increase with greater depths and greater distances from recharge areas.

Ground water is generally more highly mineralized than surface water because of the relatively slow movement of ground water and because of its more intimate contact with soluble minerals. Surface water always contains some suspended inorganic sediment and varying amounts of organic matter such as algae, bacteria, and other micro-organisms. Ground water is relatively free of these substances as a result of the filtering action that takes place as the water passes through the interstices of the aquifer.

The evaluation of water quality includes all the biological, physical, and chemical characteristics that affect the fitness of water for use. Potable water supplies must be free of harmful bacteria; toxic chemicals; objectionable odor, taste, or color; and be relatively soft and non-corrosive. Irrigation water should have low sodium and dissolved salts concentrations.

Water from the principal artesian aquifer is generally free from physical and biological contaminants and is generally of suitable quality for most uses. Water temperature is nearly constant in any individual well but may vary slightly from well to well. The temperature of water from the principal artesian aquifer is usually between 18° and 20°C, which approximates the local mean annual air temperature. Hardness as calcium carbonate is usually below 140 mg/L and often below 120 mg/L. Dissolved solids are generally below 200 mg/L, the pH usually ranges between 7.5 and 8, and the chloride concentration is normally less than 15 mg/L. In much of Beaufort County, however, the chloride concentration usually ranges between 25 and 75 mg/L, except in more seriously contaminated areas where chloride concentrations range from 500 to more than 5,000 mg/L.

Table II-H-2 shows the chemical composition of water from the principal artesian aquifer for two wells on the north end of Hilton Head

Island. The wells are located just north of Fish Haul Road adjacent Port Royal Sound. Well Bft 786 water is from the relatively impermeable zone of sandy, clayey limestone just below the upper permeable zone, while the well Bft 787 shows high dissolved solids and chlorides concentrations as a result of salt water contamination.

Table II-H-3 gives the range of concentrations, source, and significance of the major chemical constituents of water from the principal artesian aquifer within the Lowcountry area.

Saltwater Encroachment. One of the major concerns of water users on Hilton Head Island is saltwater contamination of the principal artesian aquifer. Saltwater contamination of the aquifer is widespread and in some areas a very serious problem.

Sea water contains between 19,000 and 20,000 mg/L of chloride. Water containing 500 mg/L or more of chloride has a salty taste to most persons, and water having a chloride concentration of more than 1,500 mg/L is usually considered unacceptable for human consumption.

The USEPA promulgated a secondary maximum contaminant level (SMCL) for chlorides on July 19, 1979, as 250 mg/L to be effective January 19, 1981. This SMCL has been issued as a guideline for the states for public water systems and is nonenforceable at the Federal level.

Saltwater contamination occurs primarily from: seawater entering

TABLE II-H-2

CHEMICAL QUALITY OF WATER FROM SELECTED WELLS OPEN TO THE PRINCIPAL ARTESIAN AQUIFER[1, 2]

Parameter	Well Bft 786	Well Bft 787	Drinking Water Standards (MCL's)[3, 4, 5, 6]
Well Depth (feet)	524	239	
Date of Sample	77-01-14	77-01-14	
Silica (SiO_2)	22	28	-
Iron (Fe)	0.08	0.01	0.3 (S)
Calcium (Ca)	19	83	-
Magnesium (Mg)	14	8	-
Sodium (Na)	280	32	20
Potassium (K)	27	2.0	-
Bicarbonate (HCO_3)	192	237	-
Sulfate (SO_4)	59	4.2	250 (S)
Chloride (Cl)	350	67	250 (S)
Flouride (F)	1.2	0.3	1.6 (P)
Total Dissolved Solids	867	341	500 (S)
Total Hardness (as $CaCO_3$)	110	240	-
Noncarbonate Hardness (as $CaCO_3$)	0	46	-
Specific Conductance (µmho/cm at 25°C)	1,700	600	-

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1. Reference: SCWRC, 1979, Report Number 9, "The Ground-Water Resources of Beaufort, Colleton, Hampton, and Jasper Counties, South Carolina."

2. All values in milligrams per liter (mg/l), except as indicated.

3. Maximum Contaminant Levels required by the National Interim Primary Drinking Water Regulations (NIPDWR), effective June 24, 1977, as provided for by the Safe Drinking Water Act, P.L. 93-523. Indicated by (P).

4. Maximum Contaminant Levels promulgated by EPA on July 19, 1979, as National Secondary Drinking Water Regulations, to be effective January 19, 1981. These regulations are not federally enforceable, but are intended as guidelines for the states. Indicated by (S).

5. Recommended goal for sodium proposed by EPA as amendments to the NIPDWR, published in the Federal Register of July 19, 1979.

6. Maximum Contaminant Level for flouride for study area based upon the annual average of the maximum daily air temperature falling within the range of 70.7 to 97.2°F.

TABLE II-H-3

SOURCES, SIGNIFICANCE, CONCENTRATION RANGE, AND MAXIMUM
CONTAMINANT LEVELS FOR DRINKING WATER OF COMMON
CHEMICAL CONSTITUENTS IN WATER FROM THE PRINCIPAL ARTESIAN AQUIFER[1]

	Concentration Range, in mg/L					
Constituent	Mean[2]	Minimum	Maximum	MCL, in mg/L	Principal Sources	Significance with respect to use
Silica (SiO_2)	25	.02	52	NL[3]	Siliceous minerals present in consolidated and unconsolidated deposits.	May form scale in pipes and boilers used in zeolite-type water softners and may be precipitated with other scale-forming minerals in steam boilers.
Iron (Fe)	.95	0	6.6	0.3[4]	Common iron-bearing minerals present in the rocks of the study area and iron pipes and castings.	May impart reddish-brown stain to laundry and utensils; very large quantities may color and impart objectionable taste to water and interfere with efficient operation of zeolite-type water softners. May be removed by simple aeration and filtration.
Calcium (Ca)	39	9.2	840	NL	Limestone, dolomite, and gypsum are the most common sources.	Principal cause of hardness and commonly a major constituent in scale deposits.
Magnesium (Mg)	7.1	1.8	790	NL	Dissolved from almost all rocks present in the area but primarily the ferro-magnesium minerals and magnesium carbonate, is an abundant constituent of sea waters.	Second of the major causes of hardness.
Sodium (Na)	14	4.7	6,000	20[5]	Dissolved from almost all rocks present in the area and an abundant constituent of sea water.	Large amounts in combination with chloride may give water a salty taste. Excessive amounts may reduce soil permeability and limit use of water for irrigation. Concentrations larger than 50 mg/L may cause foaming in boiler water.
Potassium (K)	2.9	0.7	300	NL	Same as sodium.	Small amounts essential for proper plant nutrition.
Bicarbonate (HCO_3)	156	66	413	NL	Action of carbon dioxide in water or carbonate minerals. Chief anion in all but the most highly mineralized water in the study area.	Causes carbonate hardness in combination with calcium or magnesium. Bicarbonate of calcium and magnesium decompose in steam boilers and hot-water facilities to form scale and release corrosive carbon dioxide gas.
Sulfate (SO_4)	[illegible]	1.3	1,400	250[4]	Gypsum, iron sulfides, and other sulfur compounds. Commonly present in many industrial wastes.	Sulfates of calcium and magnesium from hard scale and are cathartic and unplesant to taste. Sulfide-bearing ground water may contain hydrogen sulfide, which imparts a rotten egg odor to the water and may make water corrosive.
Chloride (Cl)	15	3.7	11,000	250[4]	Chloride salts, mainly NaCl, in consolidated rocks of marine origin. Abundant constituent of sea water.	In high concentrations imparts salty taste to water and makes water highly corrosive and makes water unsuitable for irrigation. May be removed by distillation, reverse osmosis or electrodialysis.
Fluoride (F)	0.3	0	1.2	1.6[6]	Occurs in trace amounts in most of the soils and rocks.	Optimum concentrations tend to reduce tooth decay of children's teeth; larger amounts may cause mottling of the enamel of teeth. Concentrations of more than 4 mg/L may affect bone structure.
Nitrate (NO_3)	.14	0	0.9	NL	Decayed organic matter, sewage, and nitrates in soil.	Values higher than the local average may suggest pollution. An excess of 45 mg/L in drinking water may cause lyanosis, the so called "blue baby" disease in infants.
Dissolved Solids	188	113	20,200	500[4]	An approximation of the total quantity of dissolved mineral matter in a water sample.	The U.S. Geological Survey has classified water according to total dissolved solids in the following manner: fresh - less than 1,000 mg/L; slightly saline - 1,000 to 3,000 mg/L; moderately saline - 3,000 to 10,000 mg/L very saline - 10,000 to 35,000 mg/L; briny - more than 35,000 mg/L.

TABLE II-H-3

SOURCES, SIGNIFICANCE, CONCENTRATION RANGE, AND MAXIMUM
CONTAMINANT LEVELS FOR DRINKING WATER OF COMMON
CHEMICAL CONSTITUENTS IN WATER FROM THE PRINCIPAL ARTESIAN AQUIFER[1]

(Cont'd)

	Concentration Range, in mg/L					
Constituent	Mean[2]	Minimum	Maximum	MCL, in mg/L	Principal Sources	Significance with respect to use
Hardness (as $CaCO_3$)	127	60	4,500	NL	Hardness is attributable to the presence of all alkaline earth minerals but is primarily due to calcium and magnesium.	Hardness in water may be recognized by the lack of suds, produced by soap. The U.S. Geological Survey has classified water according to hardness in the following manner: soft 0-60 mg/L; moderately hard 61-120 mg/L; hard 121-180 mg/L; very hard, more than 180 mg/L. Moderately hard water is generally suitable for most purposes, but does increase soap consumption; hard water may be troublesome for some industrial and domestic uses. Hardness may be removed by passing the water through a zeolite-type water softener.

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1. Reference: SCWRC, 1979, Report Number 9, "The Ground-Water Resources of Beaufort, Colleton, Hampton, and Jasper Counties, South Carolina."

2. Mean of only relatively uncontaminated samples.

3. NL - No specific maximum contaminant level.

4. Maximum Contaminant Levels promulgated by EPA on July 19, 1979, as National Secondary Drinking Water Regulations, to be effective January 19, 1981. These regulations are not federally enforceable, but are intended as guidelines for the states.

5. Recommended goal for sodium proposed by EPA as amendments to the NIPDWR, published in Federal Register of July 19, 1979.

6. Maximum Contaminant Level for study area based upon EPA criteria, NIPDWR, effective June 24, 1977.

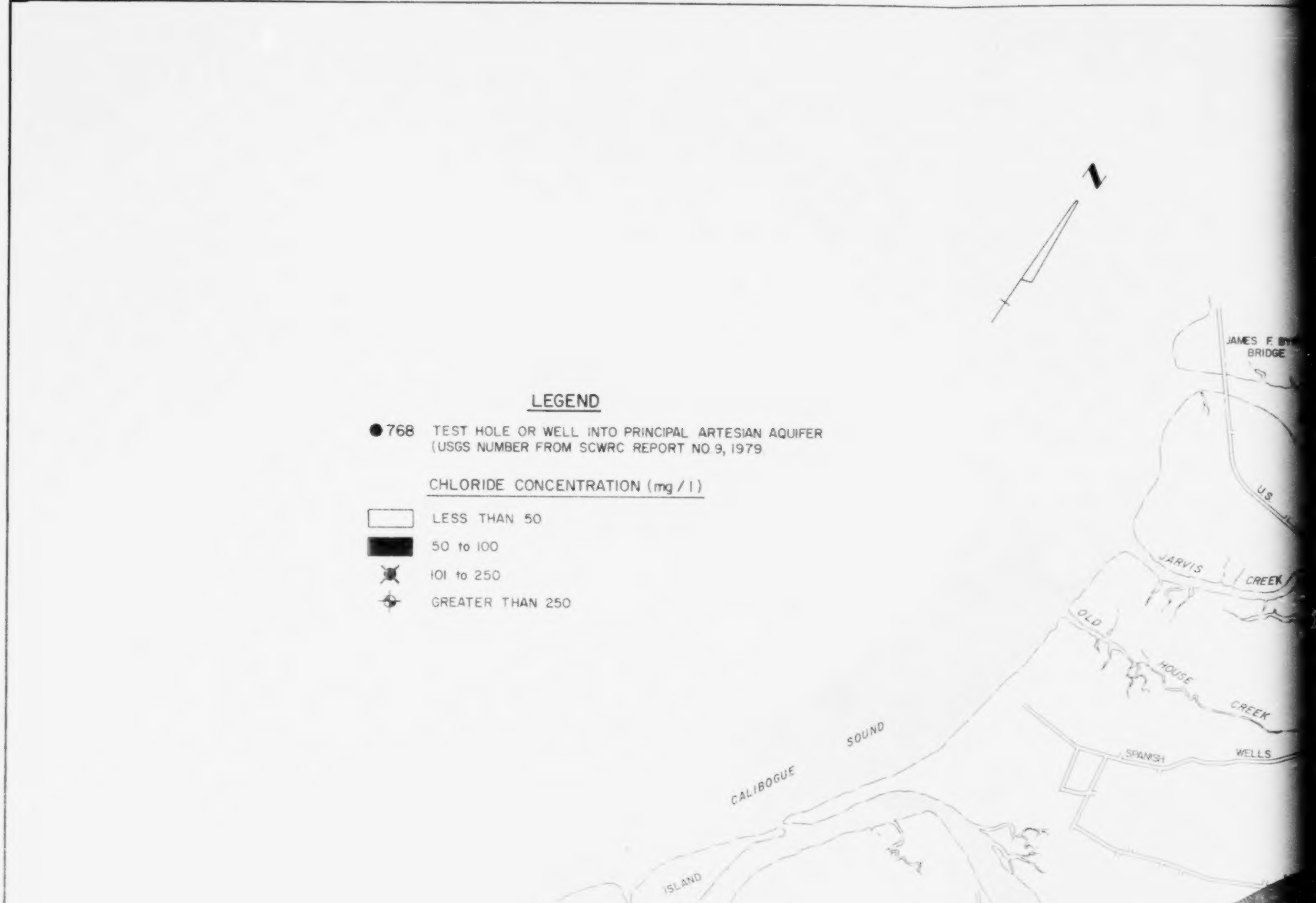
the aquifer where the overlying confining material is thin or missing, unflushed salty water in the underlying formations moving vertically upward into the aquifer, salty water in the lower part of the aquifer moving upward into the upper permeable zone, and salty water in the aquifer moving laterally. In all four cases, stress from pumpage will cause a reversal of the gradient hydraulic.

The encroachment of salty water into a freshwater aquifer is common throughout coastal areas. Saltwater encroachment usually occurs as a result of stress (pumping) and consequent lowering of the freshwater potentiometric surface below mean sea level. As freshwater is pumped from the aquifer, the potentiometric surface in the aquifer will be lowered allowing some encroachment or interface movement to a new equilibrium position. Further pumping may reverse the hydraulic gradient. With a reversal of the hydraulic gradient, sea water continues to migrate landward and eventually may contaminate the pumping well.

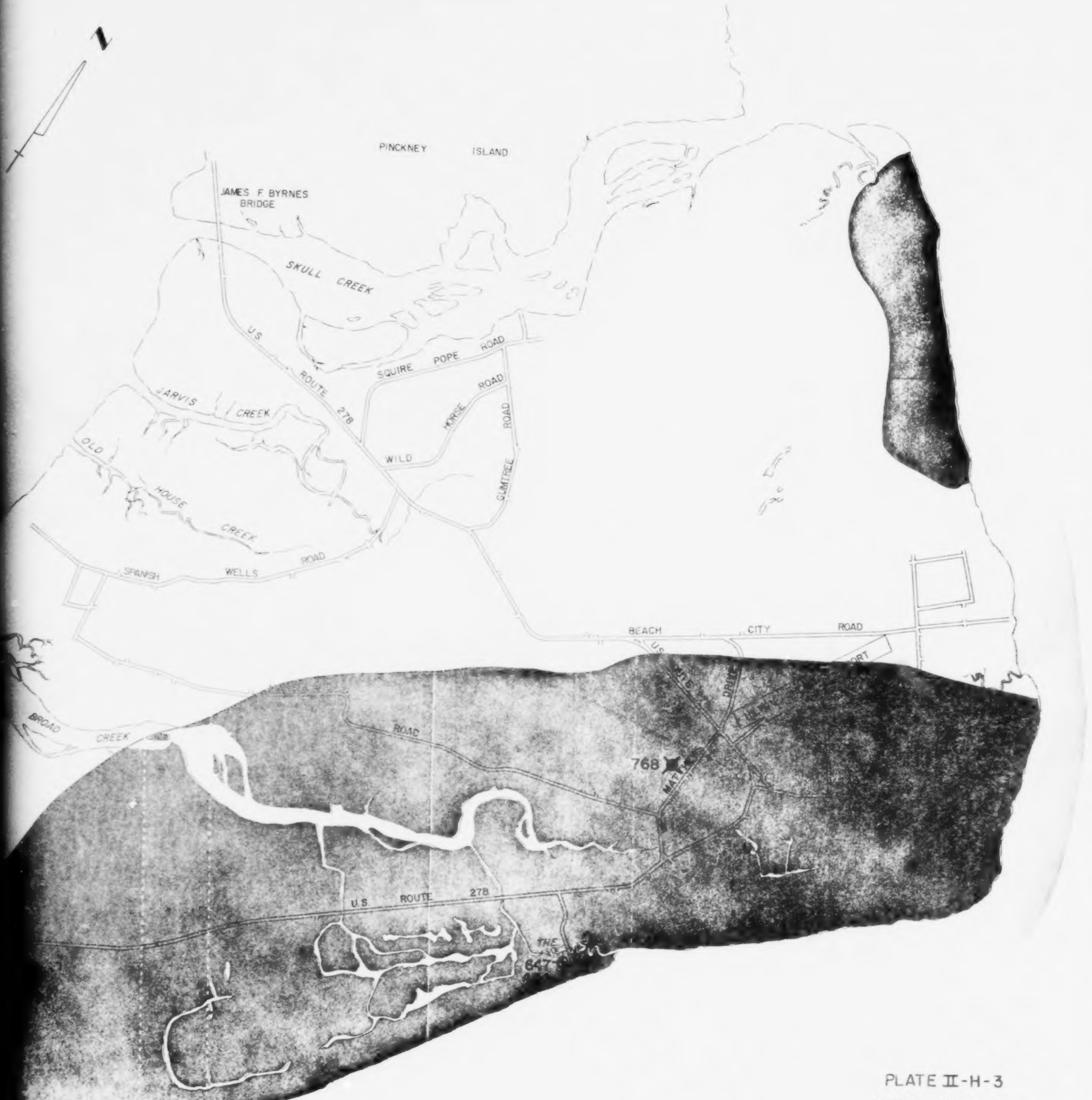
Saltwater encroachment occurring as a direct result of large ground water withdrawal from a relatively small area is presently occurring on Hilton Head Island. Prior to its development as a resort and retirement community, Hilton Head Island was sparsely populated and used relatively little ground water--probably less than 10 Mgal/yr. As a consequence of the tremendous growth that has taken place since the 1960's, total water used at Hilton Head Island has increased considerably. Pumpage for 1976 was in excess of 3 billion gallons (Table II-H-1).

As a result of these large withdrawals and the consequent lowering of the potentiometric surface, chloride concentrations in water from the upper permeable zone of the principal artesian aquifer have increased. Plate II-H-3 shows the areal distribution of chloride concentration of water in the upper permeable zone of the principal artesian aquifer at Hilton Head Island for December 1976. Water containing relatively high chloride concentrations (more than 50 mg/L) occurs along the northeastern end and along the ocean side of the island, extending landward to about the middle of the island. The boundary of this relatively high chloride water is arbitrarily placed at the 50 mg/L line of equal chloride concentration.

The high chloride concentrations for well Bft 647 (varying from 160 to 480 mg/L during the 1975-1977 period) shown on Plate II-H-3 is due to residual saltwater contamination of well Bft 494. These wells are located along the coast, just south of the Folly and are spaced about 10 feet apart. Geophysical logs run on well Bft 494 showed that the well casing ended above the confining bed. Consequently, saltwater was able to move laterally from the ocean through a beach sand overlying the upper confining bed of the principal artesian aquifer, into the open hole section of the well above the aquifer. Salty water entering the aquifer through well Bft 494 has contaminated the aquifer to the extent that it may be years before the chloride concentration in water from well Bft 647 will decrease to the level of nearby wells (50 to 100 mg/L). Well Bft 494 has been filled in with cement.


LEGEND
● 768 TEST HOLE OR WELL INTO PRINCIPAL ARTESIAN AQUIFER (USGS NUMBER FROM SCWRC REPORT NO.9, 1979
CHLORIDE CONCENTRATION (mg / l)
☐ LESS THAN 50
■ 50 to 100
101 to 250
GREATER THAN 250
N
JAMES F. BYR
BRIDGE
US
JARVIS CREEK
OLD HOUSE CREEK
SPANISH WELLS
CALIBOGUE SOUND
BUCK ISLAND
BROAD CREEK
POINT COMFORT CREEK
LAWTON CREEK
PALMETTO BAY ROAD
BRADDOCK COVE
BAYNARD CREEK
COLIGNY CIRCLE
ATLANTIC OCEAN

SOURCE SCWRC, 1979, REPORT NO 9," THE GROUND-WATER RESOURCES OF BEAUFORT, COLLETON, HAMPTON, AND JASPER COUNTIES, SOUTH CAROLINA "



N
PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
US ROUTE 278
SQUIRE POPE ROAD
WILD HORSE ROAD
GUMTREE ROAD
JARVIS CREEK
OLD HOUSE CREEK
SPANISH WELLS ROAD
BEACH CITY ROAD
BROAD CREEK
ROAD
768
647
THE
U.S. ROUTE 278

PLATE II-H-3

HILTON HEAD ISLAND
SOUTH CAROLINA

CHLORIDE DISTRIBUTION
UPPER PERMEABLE ZONE
DECEMBER, 1976

3000 0 3000 6000
SCALE IN FEET

US ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

II-H-25b

Sea water entering the aquifer primarily east of Parris Island in the vicinity of Battery Creek and Beaufort River and moving down the hydraulic gradient towards the northern end of Hilton Head Island is believed to be the most likely source of the high chlorides in wells on the island. Also, it is possible that an offshore hydraulic connection exists between the aquifer and the sea bottom to the southeast of the island. On the basis of a study of radiocarbon concentrations in ground water in the vicinity of Hilton Head Island, Back and others (1970) reported that the source of salty water at the northern end of the island is modern ocean water and that the source of salty water near the center of the island is saline formation water.

On the basis of available data, the following is believed to best explain the saltwater encroachment occurring at Hilton Head Island: (1)salty water already present in the aquifer at Parris Island and Fripp Island is moving laterally towards Hilton Head Island as a result of the extensive pumping and consequent water-level declines at Hilton Head Island and Savannah; (2) the salty water appears first at the north end of the island and then moves to the southwest down the hydraulic gradient towards Savannah; and (3) vertical upward movement of underlying salty connate water is contributing to the saltwater encroachment problem.

At present, saltwater encroachment at Hilton Head Island is limited in areal extent, and contaminated water generally contains less than 100 mg/L of chloride. The movement of the salty water to the northwest appears to be attenuated by a slight ground water divide running in a northeasterly direction (Plate II-H-2). But the saltwater encroachment boundary is not static and will continue to move downgradient. The SCWRC has estimated the rate of saltwater movement in the upper permeable zone at Hilton Head Island to be in the range of 140 to 370 feet per year, based upon a regional hydraulic gradient of about 1.5 feet per mile and the maximum hydraulic gradient in the saltwater toe under extreme rates of pumping to be about 4 feet per mile.

GROUND WATER RESOURCES MANAGEMENT

The South Carolina Ground Water Use Act of 1969 (Section 4(a)) requires that: "The South Carolina Water Resources Commission (SCWRC) upon the request of a county, municipality or other political subdivision of State government, may declare and delineate from time to time, and may modify capacity use areas of the State where it finds that the use of ground water requires coordination and limited regulation for protection of the interest and rights of residents or property owners of such areas or of the public interest." Prior to declaring a capacity use area, the act requires that an investigation be made to determine if the water problems are significant enough to warrant such an action.

The implementation of such a study was requested by the public officials of Beaufort, Colleton, Hampton, and Jasper Counties as Step 1 of a 23-step procedural process required by the 1969 Act for declaring a capacity use area. The SCWRC agreed that a comprehensive ground water investigation was needed and asked the U. S. Geological Survey to participate in a cooperative study as a part of the Survey's nationwide interest in coastal aquifers.

The Phase I study, begun in 1974, was done to determine the amount of ground water available in the four-county area and the amount which can be taken out of the ground without serious saltwater intrusion problems. The Phase I report, "The Ground Water Resources of Beaufort, Colleton, Hampton, and Jasper Counties, South Carolina", presents the results of the four-year technical study and was released in late 1979.

The Phase II project, the administrative report, was begun in December, 1978, and the report was submitted to the SCWRC in November, 1979. The Phase II report presents documented problems that are directly related to the ground water withdrawals from the Tertiary Limestone Aquifer (principal artesian aquifer). These include: (1) regional water-level declines (loss of artesian pressure) throughout large areas of the Lowcountry area and adjacent counties in Georgia, (2) progressive salt-water contamination of this aquifer in parts of the coastal area, (3) local well interference where water levels are lowered below some pump intakes, (4) interaquifer transfer resulting in local artesian pressure losses in wells and water quality impairment.

The Phase II report states that potential problems that could result from improper well design, location, and spacing include: (1)

subsidence of the land surface, which has occurred in the Savannah area, (2) local dewatering of the Tertiary Limestone Aquifer, and (3) land-surface subsidence and collapse if certain conditions are created.

The Phase II report cites the major problem in the Lowcountry area as being unregulated, uncoordinated pumpage that has given rise to the technical problems previously indicated.

In effect, there is no ground water management in the Lowcountry area. At the present time, most anyone can drill a well pretty much where they wish and pump how much they wish. There is essentially no control on well depths and type of well construction. There are no controls on amount of ground-water pumpage, water levels, and well location and spacing. The only existing controls on well location or construction are for wells utilized for public drinking-water supplies which have to be permitted by DHEC. These requirements pertain primarily to the quality (potability) of ground water which must meet certain minimum drinking-water standards established by the U. S. Environmental Protection Agency, as directed by the Safe Drinking Water Act, Public Law 93-523.

There are no requirements or minimal requirements for collecting and reporting certain technical data to a state agency. Many types of data should be submitted prior to any well-construction activity so that a prospective withdrawal can be evaluated as to its possible effects on existing water users or the aquifer.

The Phase II report specifically recommended that all of Beaufort, Jasper, Hampton, and Colleton Counties, and Edisto Island in Charleston County be declared a capacity use area.

Although not specifically required by the Ground Water Use Act of 1969 for inclusion in the Phase II report, the following ground-water management methods were recommended to be instituted following the capacity use area designation:

1. Adoption of the same type of ground water management regulations that have been promulgated for the Waccamaw Capacity Use Area in northeastern South Carolina.
2. Adoption of regulations to limit ground water withdrawals in areas where the supply is limited or where it has been documented that the movement of poor quality water is degrading a fresh water aquifer (i.e., salt-water contamination).
3. Adoption of regulations related to well-spacing, construction, and abandonment; proper testing of aquifers during well-construction operations; and the proper reporting of all such hydrogeologic data.

4. Development of a ground water monitoring program to measure continuing changes in water levels and water quality.
5. Encourage water conservation measures to limit ground water development to actual needs and to make an effort to recycle water.
6. Adoption of regulations that would require water users to use the water of lowest quality available that is or can feasibly be made suitable for a particular purpose, thereby conserving higher-quality ground water for potable uses.
7. Measures should be instituted that would provide for the best practical management of the ground water system and cause the least interference with existing water users. Such measures would include careful consideration of well- or well-field placement, proper well spacing, and the establishment of "optimum practical" pumping rates and pumping water levels. In short, prior to permitting a certain withdrawal, the water user should be required to consider the best location for a well, which may not

necessarily be his most economic location. The concentration of extremely large-capacity wells without proper spacing and depth control that are to be completed in the Tertiary Limestone Aquifer should be prohibited. Hilton Head Island was specifically identified as an area where this is critical.

8. The regulation that if a capacity use area is declared, no well in coastal Beaufort County (especially southeast of the Coosaw River), regardless of capacity or purpose, should be drilled without first obtaining a permit to do so from the SCWRC under the provisions of Section 49-5-40(a)(2) of the Ground Water Use Act.
9. The regulation that anyone wishing to install a large-capacity well or well field southwest of the Broad River would be required to also drill one or more observation wells if it is deemed necessary.
10. Maintain the SCWRC Regional Office in Beaufort to carry out the planning, management, and monitoring responsibilities if a capacity use designation is declared.

11. Establish a formal Interstate Technical Ground Water Committee composed of representatives from South Carolina and Georgia.

Regarding Item 7 above, it is stressed in the Phase II report that the prohibition of future ground water withdrawals from the Tertiary Limestone Aquifer, even in coastal Beaufort County, is unrealistic and not supported by the technical data. The recommendation provides for the best practical management of the ground water system.

Regarding Item 8 above, Section 6 of the 1969 Groundwater Act does not empower the SCWRC to require the permitting of wells within a designated capacity use area drawing less than 100,000 gallons per day for any purpose unless there is evidence of potential or continued degradation of an aquifer (i.e., salt-water contamination), as supported by the technical data in the Phase I evaluation. The primary concern for the requirement of permitting all future wells in coastal Beaufort County is not necessarily the quantity that may be withdrawn through a small-diameter well, but the possible contribution to saltwater contamination if improperly constructed. The proposed permitting program is not intended to restrict the use of ground water, but rather to insure that future wells are located and constructed properly so that they will not add to the possibility of increasing the saltwater contamination of the aquifer.

In January 1980, the Commissioners of the SCWRC voted unanimously to recommend that the Lowcountry area and Edisto Island be declared a capacity use area. The Commission also endorsed the set of recommendations set forth in the Phase II report.

The SCWRC will now schedule a public hearing(s) to present their full report and to hear evidence and arguments to the proposed action, the declaration of the capacity use area. Upon completion of the hearings the Commision shall adopt its final action with respect to declaring a capacity use area.

If the Commission finds and orders that a capacity use area shall be declared, it shall instruct its executive director to develop specific regulations for carrying out the recommendations set forth for managing the capacity use area.

The Commission would then conduct public hearing(s) on the proposed regulations.

Eventually, the final regulations would be sent to the South Carolina General Assembly for ratification.

The reaction of Beaufort County officials to the proposed action of declaring a capacity use area has been to support the concept. The Beaufort County Council passed a resolution in early 1979 endorsing a capacity use designation for the Lowcountry area.

CHAPTER II-I

ECOLOGICAL INVENTORY

The ecological description of a coastal island and surrounding water bodies is a complicated process. A large number of classification systems have been developed to summarize coastal ecosystems. The relative advantages or disadvantages of these classification systems are largely based on the purpose of the description. The ecological inventory for the Hilton Head Island Environmental Impact Statement will be utilized as a base line data source in the evaluation of alternatives and the assessment of environmental impacts. The utilization of this data base will require both a description and understanding of general dynamics of coastal island systems and specific information on the Hilton Head area.

One unique aspect of coastal systems is that they usually can not be simply divided into terrestrial and aquatic components. These two components interact dynamically to define the system. Instead, this inventory has been organized into three sections (vegetation, wildlife, and aquatic communities) emphasizing the major role of the plant communities in both the aquatic and terrestrial systems.

While considering separately the natural components of Hilton Head Island, it is important to maintain a perspective of the natural system as a whole. The Department of Interior (1979) has recently addressed this issue in a draft environmental impact statement entitled "Alternative Policies for Protecting Barrier Islands Along the Atlantic and Gulf Coasts of the United States". This document recommends a major policy shift for federal agencies so that now barrier islands are viewed as unique resources warranting special attention and needing protection from over-development. Supporting the recognition of these islands as sensitive areas are numerous factors including their value as storm buffers, fish and wildlife habitat, public recreation, and ecological productivity. The need for more protective policies has resulted from the rapid urbanization of barrier islands in recent years (often encouraged by government agencies), the destruction of many acres of valuable ecosystems on the islands, and their vulnerability to coastal storms, flooding and erosional processes.

While much has been written on coastal systems in general, there are few site specific studies for Hilton Head Island. One function of this inventory is to verify the appropriate application of general descriptions to the specific study area. This report describes the ecological systems of the study area along with data pertinent to the specific area. The general use of regional species lists has been restricted. Those species lists deemed necessary are reserved for inclusion in appendix form.

VEGETATION

The natural vegetation of the southeastern coastal islands is highly influenced by physical elements, much more so than most mainland plant communities of the region. Such factors as tides, seasonal storms, winds, salt spray, and water and soil salinity have an effect on vegetation patterns. Reflecting the influence of these physical elements is the diversity of vegetation types normally found on an island such as Hilton Head. Broadly considered, five distinct vegetation communities may be recognized; any of these types may be further subdivided. Table II-I-1 lists the vegetation communities of Hilton Head and their major subdivisions.

This inventory of the vegetation of Hilton Head Island is based on a review of published information including scientific writings, aerial photographs, and maps. Although very little botantical literature has been published specific to Hilton Head Island, there have been numerous scientific papers and books describing the vegetation of other southeastern coastal islands. Notable references include studies in South Carolina by Stalter (1974,1975), Tiner (1977), and Environmental Research Center (ERC 1975); in North Carolina by Bourdeau and Oosting (1959), Boyce (1954), and Wagner (1964); and in Georgia by Johnson, Hillestad, Shanholtzer, and Shanholtzer (1974) and Hillestad, Bozeman, Johnson, Berisford, and Richardson (1975).

The only sizable data specifically concerning the vegetation of Hilton Head Island are contained in aerial photographs and maps. Good

TABLE II-I-1

PLANT COMMUNITIES OF HILTON HEAD ISLAND

A. BEACH/DUNE

1. Upper beach
2. Fore dune
3. Interdune
4. Rear dune

B. MARITIME FOREST

1. Shrub thicket
2. Live oak forest

C. UPLAND FORESTS

1. Mixed oak-hardwood
2. Oak-pine
3. Pine
4. Seral

D. FRESH WATER

1. Aquatic
2. Marsh
3. Swamp

E. TIDAL MARSH

1. Low salt marsh
2. High salt marsh
3. Flats

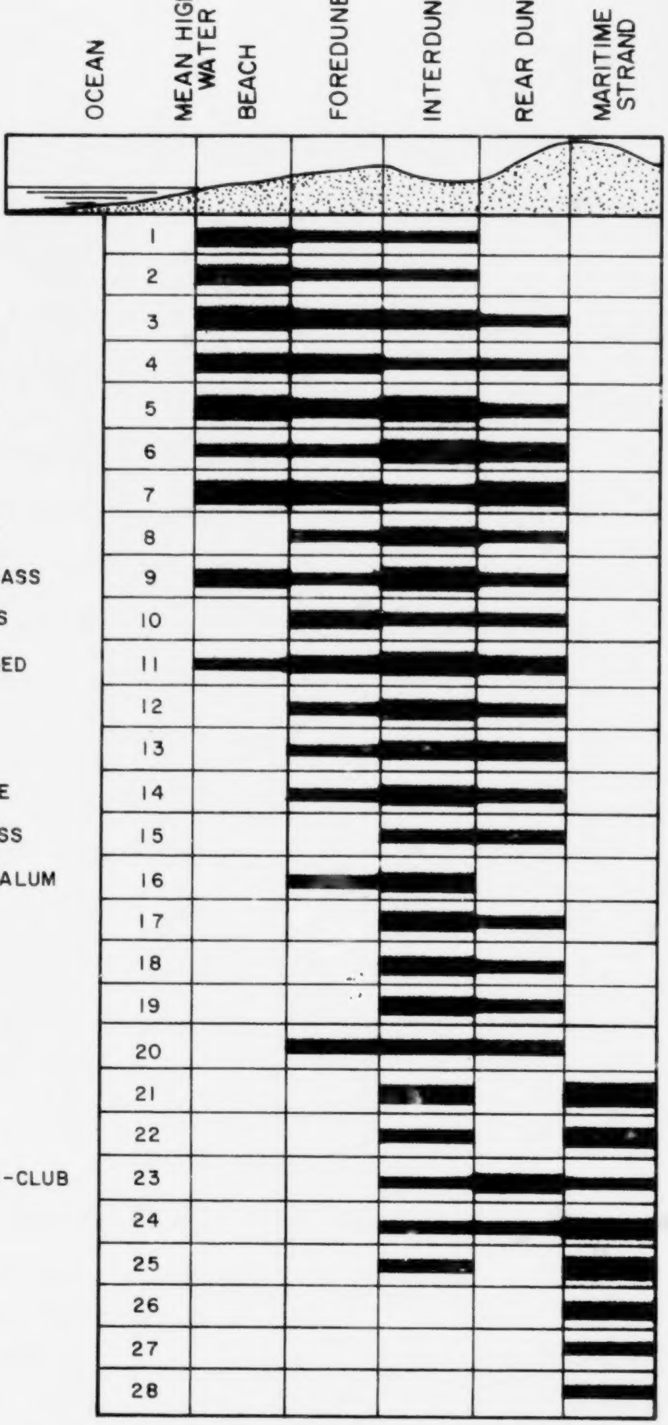
quality aerial photographs for Hilton Head were obtained from the U. S. Geological Survey (1977), and a map depicting wetland vegetation types of the island was received from the U. S. Fish and Wildlife Service (1979).

Beach/Dune Community

The beach/dune community extends from the normal high tide level of the beaches to the beginning of forests on the rear dunes. On Hilton Head this community stretches in a narrow strand along the entire eastern shore (ocean-side) of the island. Vegetational cover is relatively sparse within this community, but generally increases toward the rear dunes and in the low interdune areas. Patterns of vegetation in this community are largely determined by physical elements, which are extremely harsh. Winds, shifting sands, lack of soil moisture, high light intensities, high temperatures, and salt spray are among the important abiotic factors, but salt spray and wind probably have the greatest influence on plant distributions (Johnson, et.al. 1974).

Figure II-I-1 lists the more common plants of the beach/dune community and shows their relative abundances and distributions within the habitat. This figure represents a generalized situation, and species composition

CAKILE HARPERI, SEA ROCKET	1
SALSOLA KALI, SALT WORT	2
IVA IMBRICATA, SEA ELDER	3
CROTON PUNCTATUS, BEACH HOGWORT	4
EUPHORBIA POLYGONIFOLIA, BEACH SPURGE	5
CENCHRUS TRIBULOIDES, SANDSPURS	6
UNIOLA PANICULATA, SEA OATS	7
HYDROCOTYLE BONARIENSIS, PENNY WORT	8
SPARTINA PATENS, SALT MEADOW CORDGRASS	9
PANICUM AMARUM, SEA BEACH PANIC GRASS	10
HETEROTHECA SUBAXILLARIS, COMPHORWEED	11
ERIGERON CANADENSIS, FLEABANE	12
STROPHOSTYLES HELVOLA, WILD BEAN	13
OENOTHERA HUMIFUSA, EVENING PRIMROSE	14
TRIPLASIS PURPUREA, PURPLE SAND GRASS	15
PASPALUM VIRGINATUM, SEASHORE PASPALUM	16
ANDROPOGON SPP., BROOM SEDGE	17
DIODIA TERES, BUTTONWEED	18
LIPPIA MODIFLORA, CAPE-WEED	19
YUCCA SPP., YUCCA	20
MYRICA CERIFERA, WAX MYRTLE	21
ILEX VOMITORIA, YAUPON	22
ZANTHOXYLEM CLAVA-HERCULES, HERCULES-CLUB	23
SABAL SPP., PALMETTO	24
QUERCUS VIRGINIANA, LIVE OAK	25
PINUS TAJDA, LOBLOLLY PINE	26
PERSEA BORBONIA, RED BAY	27
JUNIPERUS VIRGINIANA, RED CEDAR	28



SOURCE: ERC(1975); JOHNSON, ET. AL (1974); HILLESTAD, ET. AL. (1975); STALTER (1974); RAYNER AND BATSON (1976).

DISTRIBUTION OF COMMON PLANT SPECIES IN THE BEACH / DUNE AND MARITIME FOREST COMMUNITIES

FIGURE II

as well as dune physiography may vary. In some areas foredunes are absent or a series of dunes may be present. In most cases, however, the same general patterns exist, with salt spray resistant plants found in exposed locations (upper dunes and beaches) and less resistant species found in less exposed areas (lee side of dunes and interdunes). *Uniola paniculata* (Sea Oats) is usually the most important plant species of the beach/dune community, especially in the more exposed locations. Other important species of exposed areas include: *Salsola kali*, *Iva imbricata*, *Croton punctatus*, *Euphorbia polygonifolia*, and *Panicum amarum*. Plant species occurring in less exposed areas are more numerous and include: *Cenchrus tribuloides*, *Spartina patens*, *Heterotheca subaxillaris*, *Oenothera humifusa*, *Andropogon* spp., *Hydrocotyle bonariensis*, and *Paspalum virginatum*.

Overall, the beach/dune community is dominated by herbaceous perennial plants, with herbaceous annuals and woody perennials of lesser importance. With the exception of *Yucca* spp. and *Iva imbricata*, woody species are usually only found in very protected interdune areas. The most common plants of the interdune areas include *Myrica cerifera*, *Ilex vomitoria*, and *Quercus virginiana* as well as the typical herbaceous interdune species.

Preservation of the beach/dune community is important on an island such as Hilton Head. The plants of this community play a valuable role in stabilizing the shifting sands of the upper beaches and dunes. These dunes are important in providing protection from high storm waters and as a source of sand for beaches. The alteration and destruction of the beach/dune plant communities in many coastal areas have resulted in greater beach erosion, the shifting and depletion of dunes, and greater vulnerability to storms (McHarg 1971; Dolan, Godfrey and Odum, 1973).

The state of South Carolina regulates the development of beaches up to and including the primary dunes (foredunes), or up to 200 feet landward from mean high water where foredunes are absent or further inland (South Carolina Coastal Council, 1978).

Maritime Forest

The maritime forest generally extends from the lee-side of the rear dunes to the limits of the salt spray influence on the island interior. This community serves as a transition between the beach/dune community toward the shore and the upland forests toward the island interior. Its vegetation is characterized by salt spray resistant woody plants, with live oak usually dominant (Bourdeau and Oosting 1959). Particularly notable features of the maritime forests are an abundance of sclerophyllous (leathery-leaved) evergreens, lianas, and epiphytes and the relative paucity of herbaceous plants (Johnson, et.al. 1974).

On the rear dunes and occassionally on the interdunes, the maritime forest intergrades with the beach/dune community. In these areas, shrub thickets generally predominate, usually intermixed with beach/dune herbs Figure II-I-1 shows the typical abundance and distribution of the common

maritime forest species in these transition areas. Typical shrub thicket species include: wax myrtle (*Myrica cerifera*), live oak (*Quercus virginiana*), yaupon (*Ilex vomitoria*), palmetto (*Sabal minor*), Hercules club (*Zanthoxylem clava-hercules*) and yucca (*Yucca* spp.). These plants often form impenetrable thickets.

Inland to the shrub thickets, live oak assumes a conspicuously dominant role, usually forming a dense canopy. Red cedar (*Juniperous virginiana*), cabbage palm (*Sabal palmetto*), and loblolly pine (*Pinus taida*) are minor components of the overstory. Red bay (*Persea borbonia*), yaupon, wax myrtle, saw palmetto (*Serenoa repens*), and palmetto (*Sabal minor*) typically compose the understory.

With regard to epiphytes, special mention should be made of Spanish moss (*Tillandsia usneoides*). According to Johnson, et.al. (1974), "ecologically and aesthetically," Spanish moss is probably the most important plant of the maritime forest, with the exception of the live oak. Draping most of the trees in extensive masses, Spanish moss not only reduces a significant amount of light to the understory but creates a humid atmosphere as well. This epiphyte also provides habitat and nesting for various species of birds, insects, and arthropods. There has been serious concern over Spanish moss in recent years because of disease from a pathogenic fungus (Johnson, et.al. 1974). In the late 1960's and early 1970's, extensive mortality of Spanish moss occurred along the southeastern coast from Florida to South Carolina. This disease apparently affected the

Spanish moss of Hilton Head Island, but the plants have since recovered (Hopkins 1979).

On Hilton Head, the maritime forest is concentrated on the eastern side of the island, extending inland from the beach/dune community of the Atlantic Shore. The dry soils of these forests and their closeness to the ocean have made the maritime forests prime areas for development. Housing, golf courses, and commercial developments have cleared or altered many of the maritime forests on Hilton Head. According to U. S. Geological Survey (1977) aerial photographs, the only large and relatively undisturbed area of maritime forest left on the island lies in the Palmetto Dunes Plantation just north of Forest Beach.

Upland Forests

Upland forests generally occur on the island interior, beyond significant influence from salt spray, tides, and water saturated soils. Of the island communities, physical factors probably exert the least effects on these forests. Man has had a great influence on this community, however, because the relatively fertile and dry soils of the upland forests are well suited for many human uses. Originally, these areas were cleared for agriculture. In recent times these forests have provided some of the best areas for real estate development.

The upland forests consist of several related and intergrading types. Excluding minor communities and subtle differences, four types may be recognized within the upland community: mixed oak-hardwood forests, oak-pine forests, pine forests, and seral areas. Some of the contrasts between these sub-communities are related to soil fertility and moisture variations, but differences are probably most strongly related to previous land usage and stage of successional development.

Mixed oak-hardwood forests represent the highest stage of succession for upland forests of the coastal islands (Hillestad, et.al 1975). They occur only in areas that have never been cleared or have been regrowing for a long time. Several species normally share dominance in these forests. Laurel oak (Quercus laurifolia), live oak (Q.virginiana) and southern magnolia (Magnolia grandiflora) are usually present as co-dominants, with cabbage palm (Sabal palmetto) and red bay (Persea borbonia) sometimes sharing dominant status. Other important species include black gum (Nyssa sylvatica), hickories (Carya spp.), pines (Pinus taeda and P.palustris), yaupon (Ilex vomitoria), and wax myrtle (Myrica cerifera).

Oak-pine forests generally occupy drier sites or represent forests in mid-successional stages of development. With time and lack of disturbances, many of these forests eventually develop into mixed oak-hardwood forests. In this type, laurel oak and pines co-dominate with other species in relatively minor proportions. Cabbage palms occassionally reach dominant or co-dominant status. Species of lesser importance include: hickories, red bay, sweetgum (Liquidambar styraciflua), southern magnolia, live oak, red cedar, sassafras, wax myrtle, and yaupon.

Seral areas, and usually pine forests, represent upland areas in the earlier stages of successional development. Occasionally pines will dominate forests in very dry soils, such as interior sand ridges. Usually seral and pine forests occur on previously cleared land; species composition reflects the length of time the areas have been abandoned. Seral areas generally undergo a rather orderly process of community changes: a herbaceous field exists for one to two years; a herb-shrub stage for three to twenty years with scattered pines quickly establishing; pine forest begins to dominate at twenty-five years and continues until about 100 years; hardwoods then begin to take over (Jenkins 1972). Seral areas and pine forests are abundant on Hilton Head, because of past agricultural clearing and more recent real estate developments. Golf courses and other cleared areas may functionally be considered seral areas even though successional development may be prevented.

The largest areas of relatively undisturbed upland forests on Hilton Head occur on the north end of the island. Large tracts of mixed oak-hardwood and oak-pine forests are present within the Gardner-Matthews, Honey Horn, and Hilton Head Plantations - north and west of Broad Creek. Pine and oak-pine forests are particularly extensive in the Long Cove Plantation, south of Broad Creek and in the northwestern corner of the island within Hilton Head Plantation.

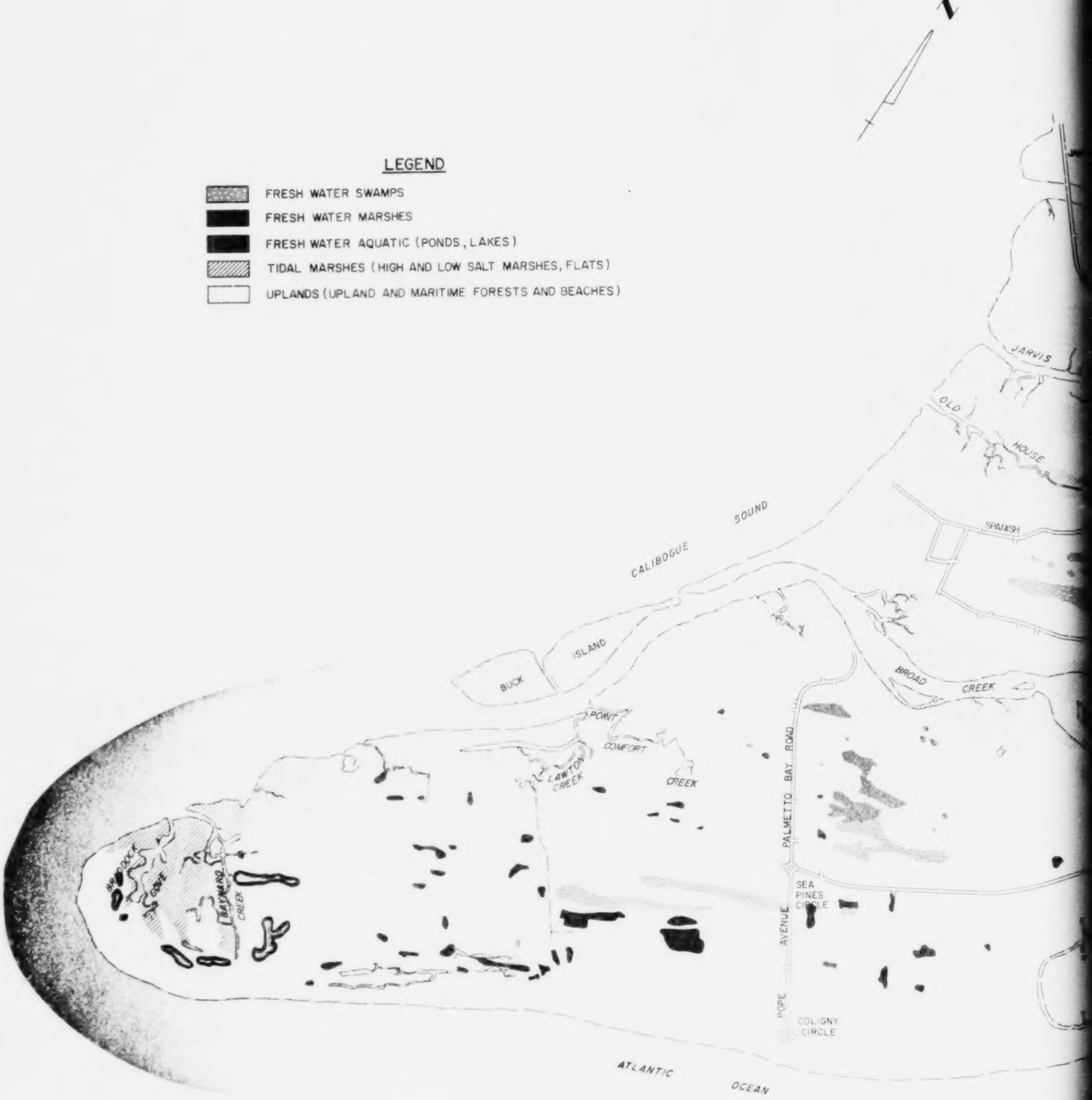
Fresh Water Community

The freshwater community includes areas covered by non-saline water or characterized by seasonally to permanently saturated soils, and vegetation adapted to saturated soil conditions. Sub-communities are determined on the basis of predominant vegetation and depth of water. Three distinctive sub-communities for Hilton Head exist: aquatic, marsh, and swamp. Plate II-I-1 shows the location of all the freshwater plant communities on Hilton Head Island. Some of the characteristic plants found in the freshwater community types are listed in Table II-I-2.

The aquatic sub-community includes permanently or semipermanently flooded areas that are unvegetated or dominated by freefloating or rooted aquatic herbs (COE 1978). Such areas include ponds or sloughs and are common on the southeastern barrier islands (Johnson, et.al. 1974). They are frequently found in low areas, often formed between old coastal dunes, where fresh or slightly brackish ground water surfaces.

The marsh sub-community occurs in occasionally or regularly flooded areas vegetated by rooted emergent plants. Plant species are predominantly herbaceous, but woody species may be present (COE 1978). Marshes may occur as a latter stage in the successional development of former ponds and sloughs, or may result where former salt marshes have been diked and tidal influences excluded (ERC 1975). Marshes also frequently border the edges of aquatic habitats. Brackish water may be present and species composition may be a mixture of the freshwater marsh types and salt water marsh types (discussed later).

The swamp sub-community occurs in occasionally or regularly flooded areas characterized by a predominance of woody vegetation (COE 1978).


N
LEGEND
▒ FRESH WATER SWAMPS
■ FRESH WATER MARSHES
■ FRESH WATER AQUATIC (PONDS, LAKES)
▨ TIDAL MARSHES (HIGH AND LOW SALT MARSHES, FLATS)
☐ UPLANDS (UPLAND AND MARITIME FORESTS AND BEACHES)
JARVIS
OLD HOUSE
SPANISH
CALIBOGUE SOUND
BUCK ISLAND
BROAD CREEK
POINT COMFORT CREEK
LAWTON CREEK
PALMETTO BAY ROAD
SEA PINES CIRCLE
POPE AVENUE
COLIGNY CIRCLE
BRADDOCK COVE
BAYNARD CREEK
ATLANTIC OCEAN

SOURCE U.S. FISH AND WILDLIFE SERVICE, 1979
NATIONAL WETLANDS INVENTORY, BEAUFORT,
SOUTH CAROLINA DRAFT MAP

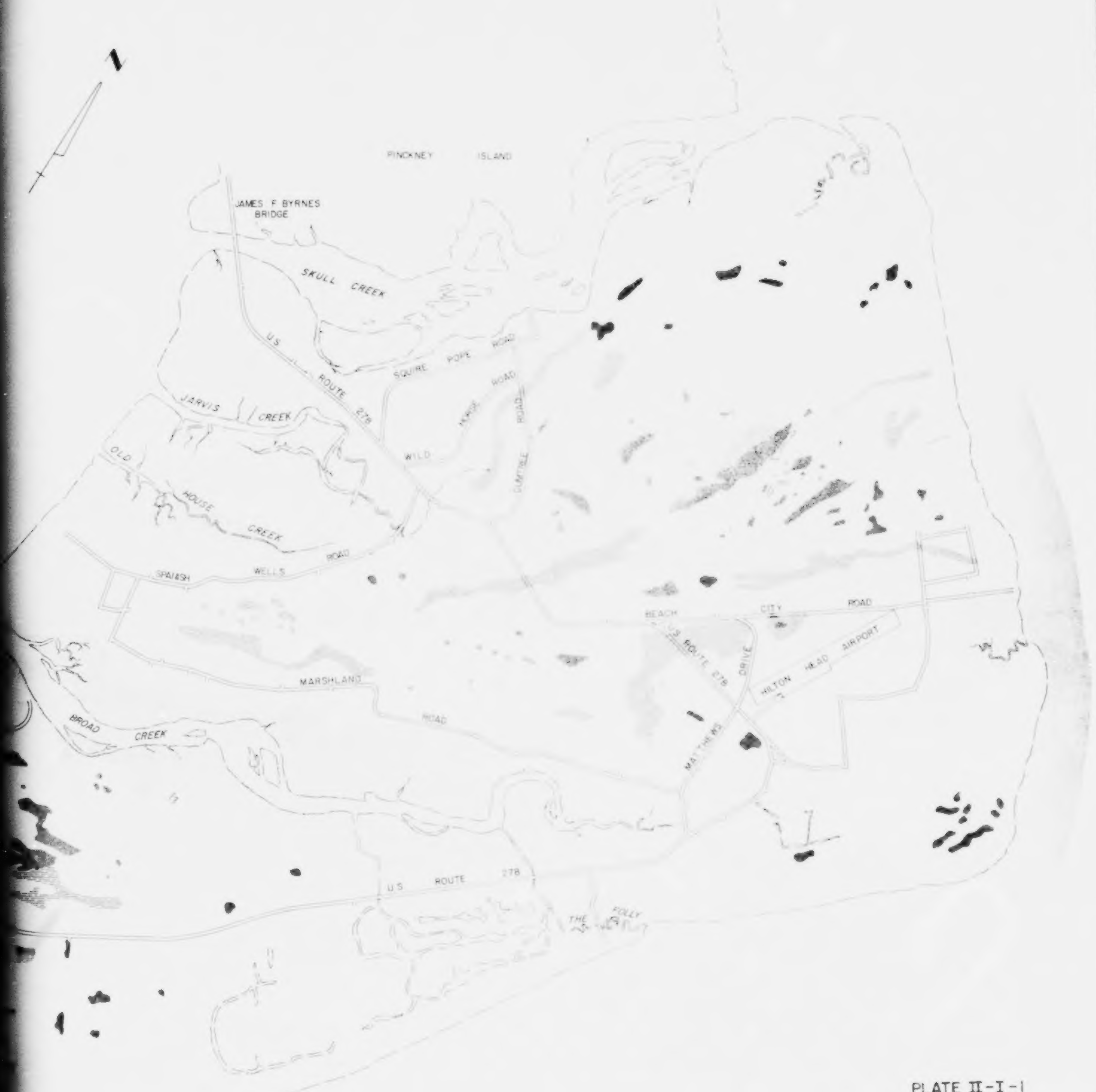

N
PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
US ROUTE 278
SQUIRE POPE ROAD
WILD HORSE ROAD
GUMTREE ROAD
JARVIS CREEK
OLD HOUSE CREEK
SPANISH WELLS ROAD
BEACH CITY ROAD
US ROUTE 278
HILTON HEAD AIRPORT
MATTHEWS DRIVE
MARSHLAND ROAD
BROAD CREEK
US ROUTE 278
THE FOLLY
3000
0
3000
6000
SCALE IN FEET

PLATE II-I-1

HILTON HEAD ISLAND
SOUTH CAROLINA

WETLANDS

US ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

TABLE II-I-2
TYPICAL PLANT SPECIES OF THE FRESH WATER COMMUNITY

Community Type	Scientific Name	Common Name	Herbaceous - H Woody - W
AQUATIC	Azolla caroliniana	Mosquito fern	H
	Brasenia schreberi	Water shield	H
	Cabomba caroliniana	Fan Wort	H
	Ceratophyllum demersum	Coontail	H
	Lemna spp.	Duckweed	H
	Myriophyllum brasiliense	Parrot's feather	H
	Najas spp.	Bushy-pondweed	H
	Nymphaea spp.	Water-lily	H
	Nuphar luteum	Yellow cow-lily	H
	Potamogeton spp.	Pondweed	H
	Spirodela spp.	Duckweed	H
	Utricularia spp.	Bladderwort	H
	Wolfia spp.	Water-meal	H
	Wolffiella floridana	Wolffiella	H
MARSH	Alternanthera philoxeroides	Alligator-weed	H
	Cladium spp.	Sawgrass	H
	Cyperus Spp.	Sedges	H
	Eleocharis spp.		H
	Hydrocotyle spp.	Pennywort	H
	Juncus spp.	Rushes	H
	Peltandra virginica	Arrow arum	H
	Pontederia cordata	Pickerelweed	H
	Sagittaria latifolia	Arrowhead	H
	Scirpus spp.	Bulrush	H
	Typha spp.	Cat-tail	H
	Cephalanthus occidentalis	Buttonbush	W
	Hibiscus spp.	Marsh-mallow	W
	Myrica cerifera	Wax myrtle	W
	Salix spp.	Willow	W
SWAMP	Acer rubrum	Red Maple	W
	Celtis	Hackberry	W
	Fraxinus spp.	Ash	W
	Gordonia lasianthus	Loblolly bay	W
	Magnolia virginica	Sweet bay	W
	Nyssa spp.	Gum	W
	Persea borbonia	Red bay	W
	Quercus nigra	Water oak	W
	Q. laurifolia	Laurel oak	W
	Taxodium distichum	Bald cypress	W
	Ulmus americana	Elm	W

*Table adapted from Johnson, et.al. (1974).

On the barrier islands, swamps represent the most advanced successional state in wet areas, commonly developing from former aquatic and marsh types (Johnson, et. al. 1974). Swamps also frequently border or surround aquatic and marsh sub-communities. Fully developed swamps are dominated by forests of tree and shrub species adapted to saturated soil conditions.

These freshwater communities are among the most ecologically valuable ecosystems. The high diversity and productivity of plants in these areas make them especially valuable as food sources and habitats for many animal species. Because of their worth, all of the freshwater community types are subject to the wetland regulations of the Army Corps of Engineers as further discussed in the section Wetland Regulations.

Tidal Marshes

Tidal marshes are one of the most extensive communities of the southeastern coast. South Carolina alone has over 430,000 acres of tidal marsh; 30 percent lie in Beaufort County (Tiner 1977). Although Hilton Head Island contains a smaller percentage of tidal marshes than most of the other coastal islands, the area occupied by this community on Hilton Head is very significant. Only the upland forest community occupies more area than the tidal marshes.

The tidal marsh consists of low, flat expanses of plants lying between the coastal islands and the mainland and adjacent to the estuaries and tidal drainage systems. On Hilton Head, most of the tidal marsh occurs on the west side of the island and adjacent to Broad Creek, (see Plate II-I-1). This community is characterized by periodic inundation by salt water and a prevalence of plant species adapted to saline water and soils. Common plant species of the South Carolina tidal marshes are listed in Table II-I-3. Community variations are largely determined by the relative frequency of tidal inundation and drainage factors. The community types discussed here include low salt marshes, high salt marshes, and flats. Maps are available from the South Carolina Coastal Council depicting the extent of high and low salt marshes on Hilton Head (and the entire South Carolina coast) but the scale of these maps (1:24,000) precludes reproduction within this report.

Low salt marshes occupy areas normally inundated by tides on a frequent basis and comprise the most extensive component of the tidal marsh community. Eighty-four percent of Beaufort County's tidal marshes are low salt marshes (Tiner 1977). This community subdivision is almost exclusively dominated by *Spartina alterniflora* (smooth cordgrass), with other plant species of only minor importance. The smooth cordgrass grows highest along tidal drainage ways and areas which are frequently flooded. Cordgrass becomes gradually smaller as elevations increase. Because of tidal flooding which provides the *Spartina* with water and nutrients, the low salt marshes are among the most productive ecosystems in the world (Odum 1971). Algae in the mud sediments and attached to the *Spartina* stems also contribute significantly to this productivity, which is fairly constant year-round (Odum 1971).

TABLE II-I-3
SPECIES LIST OF PLANTS OCCURRING IN THE TIDAL SALT MARSHES OF SOUTH CAROLINA*

Scientific Name	Common Name	Location within Salt Marsh
Ampelopsis arborea	Peppervine	Marsh-upland border
Andropogon sp.	Broom-straw	Marsh-upland border
Andropogon scoparius	Little Bluestem	Marsh-upland border
Andropogon virginicus	Broom Sedge	Marsh-upland border
Aster subulatus	Annual Salt Marsh Aster	High Marsh
Aster tenuifolius	Perennial Salt Marsh Aster	High Marsh
Atriplex patula	Marsh Orach	High Marsh
Baccharis angustifolia	False Willow	Marsh-upland border
Baccharis halimifolia	Sea Myrtle	Marsh-upland border
Bacopa monnieri	Water-hyssop	High Marsh
Batis maritima	Saltwort	High Marsh, Salt Flats
Borrichia frutescens	Sea Ox-eye	High Marsh, Salt Flats
Chenopodium album	Lamb's Quarters	Marsh-upland border
Chloris petraea	Finger Grass	Marsh-upland border
Cladium jamaicense	Sawgrass	High Marsh
Distichlis spicata	Salt Grass	High Marsh, Salt Flats
Eleocharis sp.	Spikerush	High Marsh
Fimbristylis spadicea	Salt Marsh Fimbristylis	High Marsh, Salt Flats
Hibiscus moscheutos	Rose Mallow	High Marsh
Iva frutescens	Marsh Elder	High Marsh, Salt Flats
Juncus roemerianus	Black Needlerush	High Marsh
Kosteletskya virginica	Seashore Mallow	High Marsh
Liliaeopsis chinensis		High Marsh
Limonium carolinianum	Sea Lavender	High Marsh, Salt Flats
Limonium nashii	Sea Lavender	High Marsh, Salt Flats
Lythrum lineare	Loosestrife	High Marsh
Myrica cerifera	Wax Myrtle	Marsh-upland border
Panicum virgatum	Panic Grass	Marsh-upland border
Pluchea purpurascens	Marsh Fleabane	High Marsh
Rumex verticillatus	Swamp Dock	High Marsh
Ruppia maritima	Widgeon-grass	Marsh ponds and potholes
Sabal palmetto	Cabbage Palmetto	Marsh-upland border
Sabatia dodecandra	Sea Pink	Marsh-upland border
Sabatia stellaris	Sea Pink	High Marsh
Salicornia bigelovii	Glasswort	High Marsh, Salt Flats

TABLE II-I-3 (cont'd)

Scientific Name	Common Name	Location within Salt Marsh
Salicornia europaea	Glasswort	High Marsh, Salt Flats
Salicornia virginica	Perennial Glasswort	High Marsh, Salt Flats
Scirpus americanus	Common Threesquare	High Marsh
Scirpus robustus	Salt Marsh Bulrush	High Marsh
Sesuvium maritimum	Sea Purslane	High Marsh
Sesuvium portulacastrum	Sea Purslane	High Marsh
Solidago sempervirens	Seaside Goldenrod	High Marsh, Salt Flats
Spartina alterniflora	Smooth Cordgrass	Low Marsh and High Marsh
Spartina cynosuroides	Giant Cordgrass	High Marsh
Spartina patens	Marsh-hay Cordgrass	High Marsh
Spergularia marina	Sand Spurrey	High Marsh
Sporobolus virginicus	Coastal Dropseed	High Marsh
Suaeda linearis	Sea-blite	High Marsh
Typha angustifolia	Narrow-leaved Cattail	High Marsh
Typha domingensis	Southern Cattail	High Marsh

*Table adapted from: Tiner, R.W. 1977. An Inventory of South Carolina's Coastal Marshes. S.C. Marine Resources Center, Tech. Report No. 23. Charleston, S.C.

High salt marshes are largely dominated by Juncus romerianus (Black needle rush). They form widespread stands at higher elevations above the low salt marsh. High marshes account for about 15 percent of Beaufort County's tidal marshes (Tiner 1977). These salt marshes are normally inundated only during high spring tides and storm conditions. Because these marshes do not receive regular tidal flushing, they are not as productive as low marshes. Nevertheless, the high marshes serve as important transition zones between low marshes and upland areas and provide a valuable habitat and food for many animals. In some areas, high marshes are influenced by brackish water instead of salt water. Brackish marshes usually occur in areas where salt and freshwater mix, or in high marshes that have been diked, thereby reducing saltwater flooding. These brackish marshes generally contain a mixture of the plant species found in freshwater marshes (Table II-I-2) and saltmarshes (Table II-I-3).

In the ecotone between high marshes and upland areas, many characteristic plants occur, but this border zone is usually considered part of the high marsh. (See Table II-I-3). Woody shrubs such as Myrica cerifera, Baccharus halimifolia, Iva frutescens and Sabal palmetto are frequently encountered in this zone.

Salt flats occupy areas with high salt concentrations in the soil. These areas often are near the upper edges of tidal marshes where saltwater inundations pond up and evaporate rather than draining. Vegetational cover is generally less dense in salt flats, with a characteristic assemblage of plant species adapted to high soil salinities. Common plant species of the salt flats include *Distichlis spicata*, *Batis maritima*, and *Salicornia* spp. Some flats are essentially unvegetated due to extreme soil salinities.

The value of the tidal marsh community has been revealed in numerous scientific studies and historical events. As mentioned, the high productivity of the low marshes is extremely important to wildlife in the area. In addition, tidal marshes are invaluable to coastal fisheries, providing breeding areas and habitat for many species, as well as forming the basis of an extensive coastal food web. Many estuarine and offshore fishes indirectly or directly rely on the tidal marshes as food sources.

Tidal marshes serve many other valuable functions as well: as a buffer for high tides and storm waters; purification of natural and man-made wastes in water; prevention of shoreline erosion; and aesthetic values. Legal regulations exist for the protection of tidal marshes as discussed in the section: *Wetland Regulations*.

Wetland Regulations

Some of the more valuable functions of wetlands include: high biological productivity; providing food, habitat and reproductive areas for many animal and plant species; maintaining natural drainage characteristics and sedimentation patterns, salinity distributions and other hydrological functions; shielding land areas from wave action, erosion, and storm damage; providing valuable storage areas for storm and flood waters; and purifying water through natural filtration processes (Horwitz 1978). It has been estimated that over 40 percent of the original wetlands of the continental United States were filled or drained prior to 1971 (Council on Environmental Quality 1978).

Wetland communities are now protected by federal, state, and local regulations. Federal regulation of wetlands was mandated by Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) which directed the Army Corps of Engineers (COE) to regulate the discharge of dredged or fill material that could permanently alter or destroy the characteristics of waterways and wetlands. The COE (1978) has defined wetlands as "those areas that are inundated or saturated by ground or surface water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions".

On the basis of this definition, all of the vegetation types found within the freshwater and tidal marsh communities of Hilton Head Island would be subject to federal regulation. This would include the freshwater aquatic systems, freshwater marshes, swamps, low salt marshes, high salt marshes, brackish marshes, and tidal flats as previously described. The location of these wetland communities, as determined by the National Wetlands Inventory (U. S. Fish and Wildlife Service 1979) is shown in Plate II-I-1.

The State of South Carolina requires any persons who intend to fill, remove, drain, or erect structures on, or in any way alter, critical coastal areas to obtain permits from the South Carolina Coastal Council (SCCC 1978). Critical areas include coastal waters, tidelands, beaches, and ocean front sand dunes. Protected plant communities on Hilton Head include all of the tidal marsh community and portions of the beach/dune community. Beaches and dunes are regulated up to and including the primary ocean front sand dunes or landward 200 feet from mean high water where primary dunes are absent or further inland (SCCC 1978).

The Beaufort County Development Standards Ordinance (1978) has included many wetland areas within its conservation district classification: saltmarshes, brackish marshes, freshwater marshes, bogs, swamps, lakes, ponds, and sinks. These wetland areas are delineated on special conservation district maps which are available from the Beaufort County Council and are printed on a scale of 1:24,000. The extent of saltwater wetlands indicated on these maps agrees very closely with those areas shown in the National Wetlands Inventory (See Plate II-I-1). However, the Beaufort County maps indicate very few freshwater wetland areas within the conservation district classification, even though such areas are covered by the Development Standards Ordinance. The National Wetlands Inventory map (Plate II-I-1) reveals many areas of freshwater wetlands (swamps, marshes and ponds) which are not currently indicated on the conservation district map for Hilton Head Island. These areas have apparently been exempted according to the guidelines of the Development Standards Ordinance, which granted exception to planned developments whose master plans had been preliminarily approved by the County prior to the ordinance.

Endangered, Threatened and Rare Plants

No plants in the coastal zone of South Carolina are currently listed as endangered or threatened by the U. S. Fish and Wildlife Service. Plant species must be placed on this federal list before they can be afforded legal protection by the Endangered Species Act of 1973 (P. L. 93-205).

Despite federal listings, there are many rare plant species which occur in South Carolina's coastal zone. A publication of the State of South Carolina, Native Vascular Plants Endangered, Threatened, or Otherwise in Jeopardy in South Carolina (Raynes, ed. 1979), lists a number of rare plants from the region. Although the plants on this state list are not protected by any legal regulations (unless also included on the federal list), this publication provides valuable information concerning rare plants. Some of these plants may be placed on the federal list in the future, and all of these species should be protected from destruction whenever possible.

Based on this publication, Douglas Rayner, a botanist for the South Carolina Wildlife and Marine Resources Department, has provided a list of rare plants known to occur or possibly occur on Hilton Head Island (See Table II-I-4). This table provides the rarity status for known species and habitat information for those species of certain or very likely occurrence.

As seen from Table II-I-4, two plant species, Litsea aestivalis and Pinckneya pubens, are known to presently occur on Hilton Head Island. An additional eight species are very likely to be found: Amaranthus pumilus, Canna flaccida, Hemicarpha micrantha, Ipomoea macrorhyza, Nyssa ogeche, Rhapidophyllum hystrix, Sageretia minutiflora, and Spiranthes laciniata. The most likely habitats for these species are the freshwater and beach/dune communities.

WILDLIFE

The wildlife of the southeastern coastal islands reflects an unusual interaction of factors. The abundance of food sources and diversity of habitats tend to encourage an abundance and diversity of animal species. On the other hand, the isolation of the islands from mainland areas, their relatively young geologic age, and their limited size tend to reduce animal diversity and abundance.

The relative abundance and diversity of animal groups on the islands appear to be closely related to their mobility. More mobile

TABLE II-I-4
RARE PLANTS OCCURRING OR POSSIBLY OCCURRING ON HILTON HEAD ISLAND

A. Rare plants known to occur on Hilton Head Island.

Litsea aestivalis, Pond spice, Of Regional Concern* Recommended for Nationally Threatened Status in the Federal Register of July 1, 1975; found in Whooping Crane Pond; probably present in other lime sink areas on Hilton Head.

Pinckneya pubens, Georgia fever bark, Of Statewide Concern. Recommended for Nationally Threatened Status in the Federal Register. Reported near a nursery or botanical garden; some question as to whether the population is wild or planted.

B. Rare plants known from Beaufort (B), Charleston (C), or Jasper (J) counties. Any of these plants might be found on Hilton Head Island. Species preceeded by a double asterisk are very likely to be found on Hilton Head Island.

Agrimonia incisa, Incised groovebur, Of Statewide Concern. Recommended for Nationally Threatened Status in the Federal Register of July 1, 1975; (C).

**Amaranthus pumilus, Coast pigweed, Of Statewide Concern. Found on coastal beaches and sand dunes; (C).

Anthaenantia rufa, Purple silkyscale, Of Concern; Status Unresolved; (C) and (J).

Balduina uniflora, Single-flowered balduina, Of Concern; Status Unresolved: (J).

Botrychium lunarioides, Winter grapefern, Of Concern; Status Unresolved; (C).

**Canna flaccida, Golden canna lily, Of Statewide Concern. Found in pine savannahs and marshes; (B), (C) and (J).

Chrysobalanus oblongifolius, Gopher apples, Of Statewide Concern; (J).

Crotonopsis linearis, Narrow-leaved rushfoil, Of Concern; Status Unresolved; (J).

Cynanchum scoparium, Leafless swallow-wort, Of Regional Concern. Known only from early collections around Bluffton; (B).

Dicerandra odoratissima, Rose dicerandra, Of Regional Concern; (J).

Dionaea muscipula, Venus' flytrap, Of National Concern. Recommended for Nationally Threatened status in the Federal Register of July 1, 1975.

Habenaria integra, Yellow fringeless orchid, Of Statewide Concern; (C) and (J).

Halesia diptera, Two-winged silverbell, Of Statewide Concern; (J).

**Hemicarpha micrantha, Common hemicarpha, Of Statewide Concern. Found on sandy strands; (B).

**Ipomoea macrorhiza, Large-rooted morning glory, Of Statewide Concern. Found in sandy open clearings and beaches; (B).

TABLE II-I-4 (cont'd)

**Nyssa ogeche, Ogeechee plum, Of Statewide Concern. Found in swamp and bog forests; (B).

Pieris phillyreifolia, Climbing fetterbush, Of Regional Concern. Recommended for Nationally Threatened Status in the Federal Register of July 1, 1975: (C).

**Rhapidophyllym hystrix, Needle palm, Of Regional Concern. Recommended for Nationally Threatened Status in the Federal Register of July 1, 1975. Found in swamps and hammocks; (B).

Rudbeckia mollis, Soft-haired coneflower, Of Regional Concern; (J).

**Sageretia minutiflora, Small-flowered buckthorn, Of Regional Concern. Found on shell mounds and calcareous hammocks; (B) and (C).

Sarracenia rubra, Sweet pitcher plant, Of Statewide Concern. Recommended for Nationally Threatened Status in the Federal Register of July 1, 1975; (C).

Schisandra glabra, Bay starvine, Of Regional Concern. Recommended for Nationally Threatened Status in the Federal Register of July 1, 1975; (C).

Schwalbea americana, Chaff-seed, Of Statewide Concern; (C).

Scleria baldwinii, Baldwin's nutrush, Of Statewide Concern; (C).

**Spiranthes laciniata, Lace-lip ladies' tresses, Of Statewide Concern. Found in cypress savannahs, marshes and wet pinelands; (C).

Spiranthes longrilabris, Giant spiral-orchid, Of Statewide Concern; (J).

C. Rare plants not previously found in Beaufort, Charleston or Jasper Counties that might be found on Hilton Head Island.

Cliftonia monophylla, Buckwheat tree, Of Concern; Status Unresolved. Found in wet, sandy, acid soils of non-alluvial swamps and bogs.

Lachnocaulon beyrichianum, Southern bog-buttons, Of Concern; Status Unresolved Recommended for Nationally Threatened Status in the Federal Register of July 1, 1975. Found in sandy pine-palmetto flats in areas with karst topography; could be in the Whooping Crane Pond area.

Lilaeopsis carolinensis, Carolina lilaeopsis, Of National Concern. Found in sunny mud flats of freshwater ponds and marshes.

Parnassia caroliniana, Carolina grass-of-parnassus. Of National Concern. Found in savannahs.

Zephranthes simpsonii, Rain lily. Of National Concern. Recommended for Nationally Threatened Status in the Federal Register of July 1, 1975. Found in low, sandy pinelands.

Source: D.A. Rayner, Field Botanist, S.C. Heritage Trust Program. (22 October 1979) Personal letter.

*Status is from: Rayner, D.A. and Committee. 1979. Native Vascular Plants Endangered, Threatened or Otnerwise in Jeopard in South Carolina. Museum Bulletin No. 4, S.C. Museum Commission, Columbia, S.C.

1. Of National Concern.
   Species listed in this category are endangered or threatened throughout their entire range in the continental United States.

2. Of Regional Concern.
   Each species listed here is threatened or endangered throughout a significant portion of its range that includes South Carolina and other states of our general region. In parts of its range outside of our region, the species may be of no particular concern, but in our part of the country, its rarity and the status of its populations over a wide area are a cause of concern because of definite, widespread rarity and/or threats of a more immediate nature. South Carolina populations that are far disjunct from the main populations of the species also are listed here.

3. Of Statewide Concern in South Carolina.
   Species listed here are those which are not of particular concern on a national or regional level. Listings here include species which are considered to be endangered or threatened only in S.C., species whose peripheral populations extend into S.C., species which warrant scrutiny because of the tangible possibility of future threats to their well-being, and species likely to be exploited within the State.

4. Of Concern; Status Unresolved.
   Species listed in this category are those for which insufficient information is available to base a careful determination of status. However, if further information were available, there is reason to believe that these species could possibly meet criteria for listing in one of the three above listed categories.

**Species which are very likely to occur on Hilton Head Island.

animal types, which can migrate easily from less favorable to more favorable conditions, have colonized the islands much more successfully than less mobile animals. Not surprisingly, birds are the most abundant and diverse animals, with 365 species having been reported from the South Carolina coast (Forsythe 1978). This figure represents the majority of bird species known from the entire state (SCCC 1979). The species diversity of other animal groups has generally been found to be less than half that of adjacent mainland areas. For example, studies on Cumberland Island, Georgia found mammal diversity to be only 44% of that of the nearby mainland (Hillestad, et.al. 1975). Larger and more mobile mammals appear to be better represented than smaller and less mobile species.

The degree of influence exerted by isolation, geologic age and island size on wildlife populations should be less for Hilton Head Island than the other coastal islands. This is because Hilton Head is closer to the mainland than most of the southeastern islands, is one of the older islands geologically, and is the largest of these islands. Additionally, Hilton Head has more upland areas, and is more similar to nearby mainlands than most of the other coastal islands. Although it has the characteristic habitat diversity of the islands, extensive human developments on Hilton Head have probably reduced animal diversity and abundance in recent years. (Hopkins 1979).

In the following discussions, wildlife occurrences are considered according to three taxonomic groupings: birds, mammals, and herpetofauna (reptiles and amphibians). Within each group, special attention is paid to animal habitats, because these largely determine species distributions and abundance.

Comprehensive species lists are presented in Appendices II-I-1, II-I-2, and II-I-3. Because these data were drawn from sources describing the coastal region in general, these lists provide an indication of species which may occur on Hilton Head Island as well as those species that have been verified to occur there.

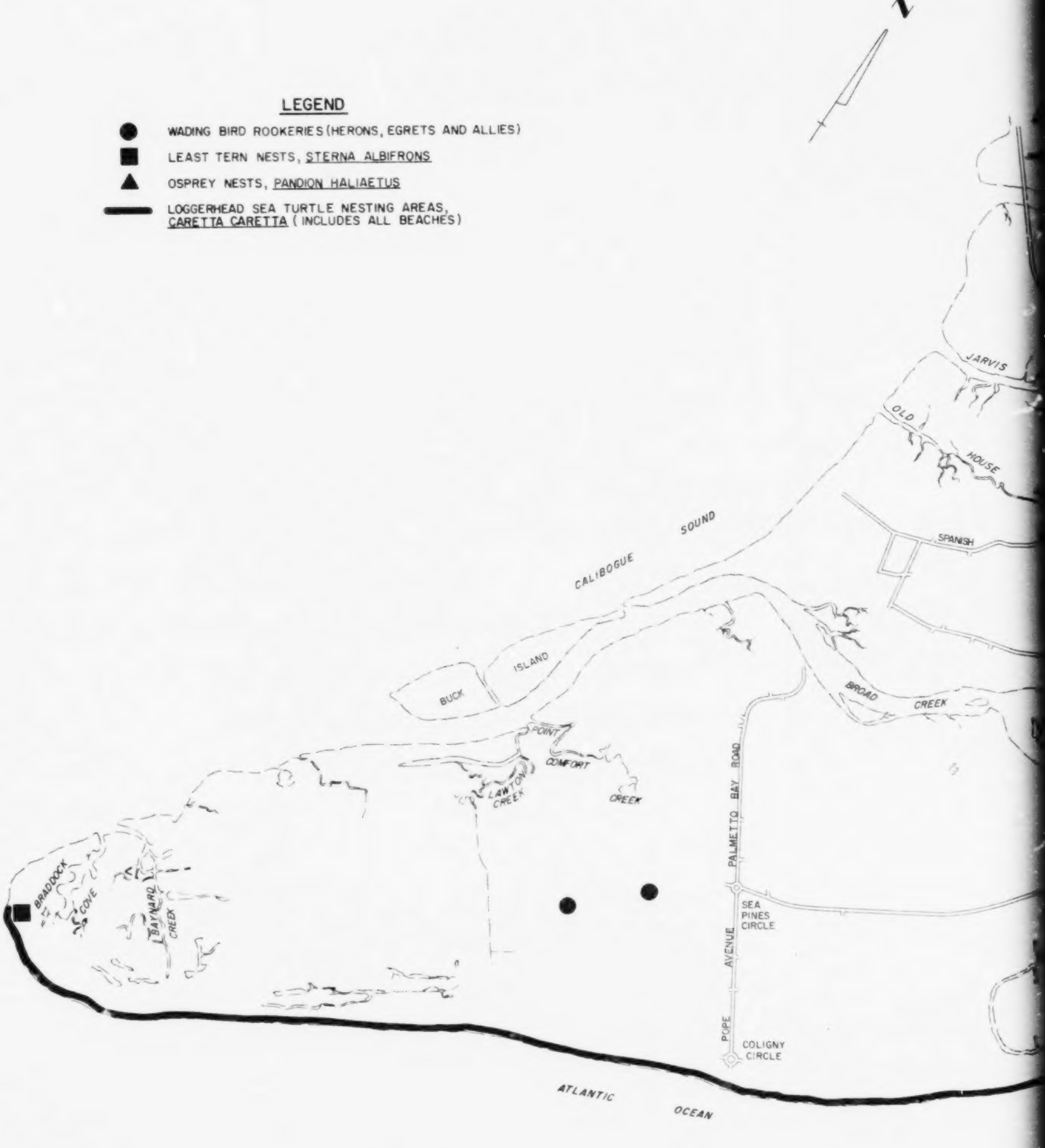
Birds

Although figures vary, a tremendous number of birds are known to occur on the southeastern coastal islands. Forsythe (1978) listed 365 species of birds known from the coast of South Carolina, and Shanholtzer (1974) reported 323 species of birds thought to occur in the coastal region of Georgia. Information from these two sources was used to summarize bird species, their abundances, and habitat preferences, as presented in Appendix II-I-1. Although all of these species would not be expected to occur on the island at any one time, many should be expected to occur there at different times over a period of years. Members of the Audubon Society have recorded 267 species of birds on Hilton Head Island (Unofficial records 1960 - 1974); these species are noted in Appendix II-I-1. For comparison's sake, a recent study on Kiawah Island (Chamberlain 1975) recorded 165 species of birds during a thirteen-month period. Observations on Bull Island, which is adjacent to Hilton Head have recorded 237 species over a fifty-year period (Chamberlain 1975).

Bird diversity in the South Carolina coastal zone can be partially attributed to its location within the Atlantic Coast Flyway, a major bird migration route (Grosvenor 1979). Although many of the birds which occur in the coastal region only rest and feed there, many species are known to nest in the area. Hillestad, et.al. (1975) report that over 30% of the birds recorded from the Georgia coast are known to breed there, representing a larger number than any other area of the state. Of these 101 breeding species, 32 are ground nesters, 47 are tree nesters, and 22 nest in cavities (Hillestad, et.al. 1975).

With regard to breeding populations of birds, mention should be made of bird rookeries. At scattered locations along the coast, many species of birds, usually wading birds, congregate in large concentrations to breed. These rookeries may vary in location and species composition from year to year (Hillestad, et.al. 1975), but usually are maintained when not encroached upon by development, pond drainage, or excessive disturbances (Johnson, et.al. 1974). At least eight rookeries have been identified on Hilton Head Island (Jenkins 1972; Greeter 1979). The locations of rookeries are depicted in Plate II-I-2, and include rookeries for wading birds (herons, egrets, and allies), least tern, and osprey nests.

The rookeries located at Whooping Crane Pond and Cypress Swamp within the Hilton Head Plantation were once quite large, but have been reported to be declining in usage (Jenkins 1972). Jenkins reported that the Whooping Crane Pond rookery had declined from about 2000 nesting


LEGEND
● WADING BIRD ROOKERIES (HERONS, EGRETS AND ALLIES)
■ LEAST TERN NESTS, STERNA ALBIFRONS
▲ OSPREY NESTS, PANDION HALIAETUS
LOGGERHEAD SEA TURTLE NESTING AREAS, CARETTA CARETTA (INCLUDES ALL BEACHES)
N
JARVIS
OLD HOUSE
SPANISH
CALIBOGUE SOUND
BUCK ISLAND
BROAD CREEK
POINT COMFORT CREEK
LAWTON CREEK
PALMETTO BAY ROAD
BRADDOCK COVE
BAYNARD CREEK
SEA PINES CIRCLE
POPE AVENUE
COLIGNY CIRCLE
ATLANTIC OCEAN

SOURCE: GREETER, S. 1979. PERSONAL COMMUNICATION
ENVIRONMENTAL PLANNER, SOUTH CAROLINA WILDLIFE
AND MARINE RESOURCES DEPARTMENT

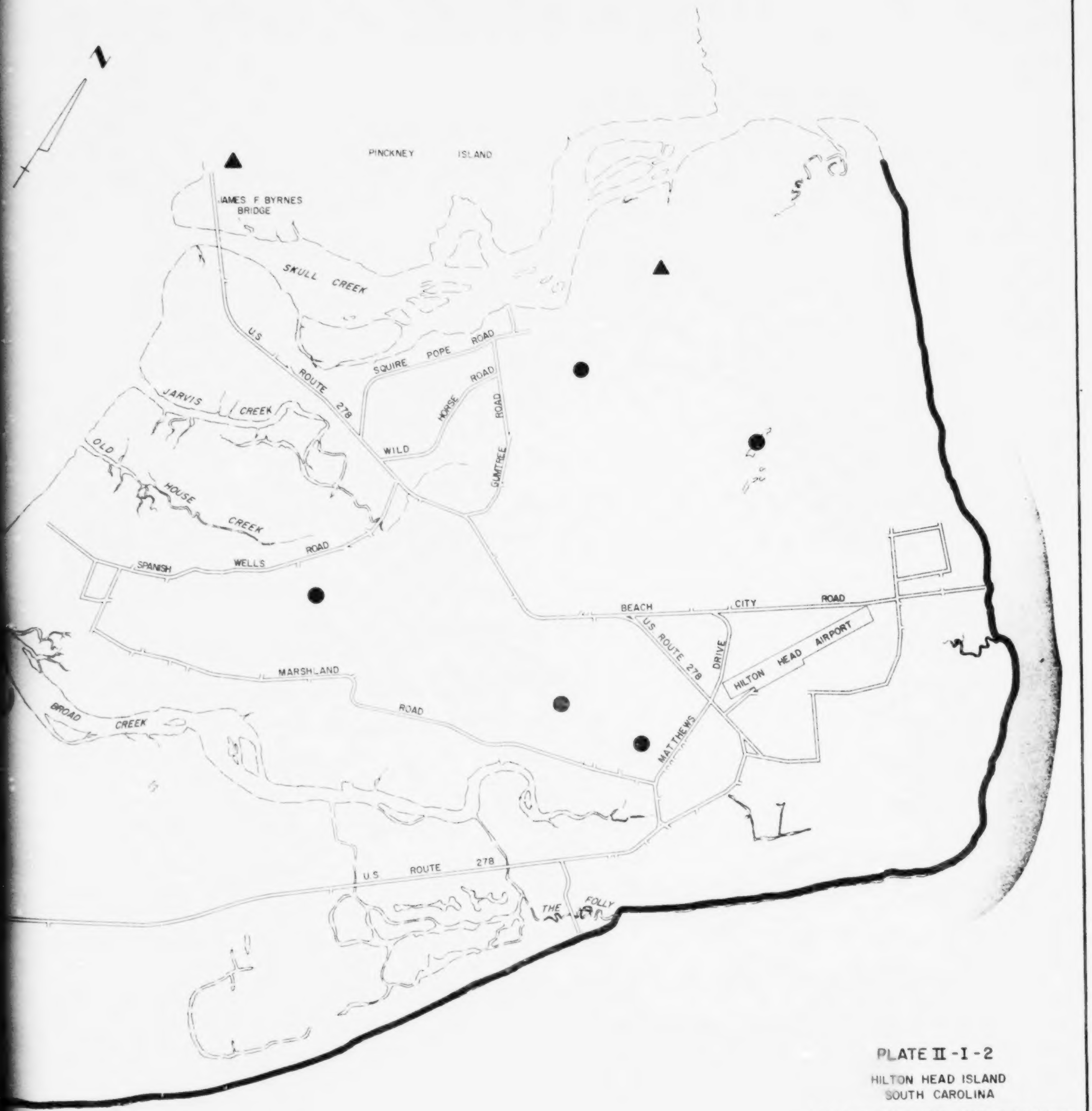

N
PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
U S ROUTE 278
SQUIRE POPE ROAD
WILD HORSE ROAD
GUMTREE ROAD
JARVIS CREEK
OLD HOUSE CREEK
SPANISH WELLS ROAD
BEACH CITY ROAD
U S ROUTE 278
DRIVE
HILTON HEAD AIRPORT
MARSHLAND ROAD
BROAD CREEK
MATTHEWS
U S ROUTE 278
THE FOLLY

PLATE II - I - 2

HILTON HEAD ISLAND
SOUTH CAROLINA

LOCATIONS OF SIGNIFICANT ROOKERIES AND NESTING AREAS

3000
0
3000
6000

SCALE IN FEET

US ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

pairs in 1963 to about 250 nesting pairs in 1972. Within the same time frame, Jenkins also reported that osprey nests had declined from ten to three, and bald eagles from five to none on the island. It is probable that developments on the island have helped account for the decline of these rookeries, although the Audubon Society reports that these sites are still being used by wading birds (Newhall, pers. comm. 1979). Encroachments on these rookeries may be offset by wildlife management programs being conducted on Pinckney Island, to the west of Hilton Head. Pinckney Island is currently being managed by the U. S. Fish and Wildlife Service to encourage wild bird populations.

The great diversity and abundance of birds on the coastal islands can be directly attributed to their diversity of habitats and abundance of food sources. As presented in Appendix II-I-1, these habitats may be divided into five types: shore, forests, seral, freshwater, and estuarine. Table II-I-5 lists the different bird habitats and their relative use by bird species. It should be emphasized that most bird species will utilize more than a single habitat type.

The shore habitat includes offshore areas and beaches, dunes, and mudflats. This habitat is largely used by migratory shore birds, but some species nest on the dunes and mudflats. The shore habitat is relatively safe from encroachments. Most species only use the habitat for feeding and resting. Heavy beach use would tend to inhibit shore nesting birds, but some protection is conferred by South Carolina regulations

TABLE II-I-5
HABITAT USAGE BY BIRD SPECIES ON THE COASTAL ISLANDS

Habitat Type	Usage (% of Bird Species) Georgia Coast (1)	South Carolina Coast (2)
Shore	17	10
Forests	27	25
Seral	18	12
Freshwater	16	26
Estuarine	22	27

(1) adapted from Shanholtzer (1974)

(2) adapted from Chamberlain & Chamberlain (1975)

protecting the beaches and primary dunes.

Forests are among the most valuable habitats for bird species, particularly with regard to providing food, cover, and nesting areas. Hardwood and live oak forests are especially rich in food sources (Jenkins 1972). The habitat diversity provided by live oak forests will become in future years increasingly important for many bird species as mainland live oak forests are reduced in extent (Johnson, et.al. 1974). However, the upland areas occupied by forests (live oak and otherwise) on Hilton Head are also prime areas for development, and some have been greatly reduced in extent.

Seral habitats include pastures, old fields, and other open areas. These areas are often in various stages of successional development preceding later forest stages. Seral habitats contain many plants providing valuable food sources. A particularly important aspect of seral areas is its "edge effect" with other habitat areas (Jenkins 1972). Many species of birds and other animals occur in greater abundance in the edge zones between different habitat types, particularly seral areas and forests. Seral areas are abundant on Hilton Head due to clearings resulting from developments, agriculture, and golf courses.

The freshwater habitats include ponds, marshes, and swamps and are valuable to many bird species, especially wading birds and waterfowl. Freshwater habitats have abundant food sources and are sometimes used intensively as rookeries by wading birds. Freshwater habitats are particularly susceptible to encroachments because of their relatively limited extent and susceptibility to water pollution, as well as filling.

The estuarine habitat includes the salt marshes as well as tidal creeks and estuaries. Relatively few bird species utilize the salt marshes, but the estuaries are extremely valuable. Food sources are particularly abundant in this habitat because of the high productivity of the salt marshes. The estuarine habitat is relatively secure from encroachments from developments because of laws regulating its use, but due to its tidal nature could be susceptible to water pollution effects.

Eight endangered species of birds are of possible occurrence on Hilton Head. These birds are listed in Table II-I-6. Of these endangered species, only the Red Cockaded Woodpecker and the Brown Pelican are presently known to occur on Hilton Head Island. The Brown Pelican species feeds and rests in the shore and estuarine habitats, but is not known to nest in the area. Red Cockaded Woodpeckers were spotted during the local Audubon Society's 1979 bird count (Island Packet, January 1980); these birds typically inhabit overmature pine trees infected with red heart disease (Odom, et al 1977) in upland forests. The bald eagle was reported by Jenkins (1972) to have nested on the island in 1963, but to have been absent in 1972. The Audubon Society has recorded sightings of the peregrin falcon between 1960 and 1974, but it is not known if this species is still present on the island.

TABLE II-I-6
THREATENED AND ENDANGERED ANIMAL SPECIES OCCURRING OR POSSIBLY OCCURRING ON HILTON HEAD ISLAND

Status - E=Endangered
T=Threatened

Mammals	Status
Florida cougar (Felis concolor coryi)	E
Florida manatee (Trichechus manatus)	E
Blue Whale (Balaenoptera musculus)	E
Finback Whale (B. physalus)	E
Humpback Whale (Megaptera novaeangliae)	E
Right Whale (Eubalaena spp.)	E
Sei Whale (Balaenoptera borealis)	E
Sperm Whale (Physeter catadon)	E
Birds	
Arctic peregrin falcon (Falco peregrinus tundrius)	E
Bachman's warbler (Vermivora bachmanii)	E
Bald eagle (Haliaeetus leucocephalus)	E
*Brown pelican (Pelecanus occidentalis)	E
Eskimo Curlew (Numenius borealis)	E
Ivory-billed Woodpecker (Compephilus principalis)	E
Kirtland's warbler (Dendroica kirtlandii)	E
Red-Cockaded woodpecker (Picoides borealis)	E
Reptiles	
*Alligator (Alligator mississippiensis)	T
Indigo Snake (Drymarchon corais)	T
Green turtle (Chelonia mydas)	T
Hawksbill turtle (Eretmochelys imbricata)	E
Leatherback turtle (Dermochelys coriacea)	E
*Loggerhead turtle (Caretta caretta)	T
Fishes	
Shortnose sturgeon (Acipenser brevirostrum)	E

*Known to presently occur on Hilton Head Island.

Mammals

Fifty mammals are known to occur in the coastal region of South Carolina, as listed in Appendix II-I-2. Some species, such as the cougar, are of uncertain or very rare occurrence, although they may have once been more common. Other species, such as the armadillo, have been extending their ranges and may be more widespread than records indicate. Additionally, many species, such as the feral swine and Norway rat, are introductions that have become successfully established, often at the expense of native species.

Of the mammals listed in Appendix II-I-2, 16 species (32 percent) have been verified to occur on Hilton Head Island. This number represents 47 percent of the number of species verified from the adjacent mainland of Beaufort County, and is probably somewhat low because little intensive sampling has been done on the island. Records are probably better for the larger and more visible species, such as deer, squirrels, and raccoons, than for smaller, less visible species such as mice, shrews, and bats. For instance, the marsh rice rat is almost certain to exist on Hilton Head Island, for it is common in marshes and dunes of all of the coastal zone, but occurrences of it have not been confirmed (Jenkins 1972).

Although habitat is extremely important to mammals, most species are not entirely specific to particular habitat types and often utilize a variety of environments. General habitat needs of the various mammals are listed in Appendix II-I-2, and the relative importance of these habitats can be seen from Table II-I-7. Jenkins (1972) maintains that the oak-hardwood

TABLE II-I-7

MAMMAL SAMPLING ON KIAWAH ISLAND, S.C.*

Habitat	Trapnights (#)	Trapping Success(%)	House Mice	Cotton Mice	Least Shrews	Cotton Rat	Wood Rat	Rice Rat	Oppossum	Raccoon	Observed
Dunes	1,735	5.4	47	2	4	15	1	3	3	10	deer, wild hogs, cotton tail rabbit, otter, bobcat
Woodlands	2,266	2.5	-	24	4	1	3	-	13	11	flying squirrel, bobcats
Salt marsh	220	3.2	-	1	2	1	-	3	-	-	deer, raccoons, oppossum
Pond marsh edge (Freshwater Aquatic)	597	4.7	-	6	3	7	8	4	-	-	deer, wild hogs, raccoons
Fields (Seral)	728	2.8	1	16	2	-	-	1	-	-	deer, wild hogs, raccoons, bats, marsh rabbits

*Table derived from data by M. R. Pelton in: E.R.C. (1975) Environmental Inventory of Kiawah Island. ERC: Columbia, S.C.

(especially live oak) forests are the most important wildlife habitat on Hilton Head, equalled only by the freshwater aquatic habitats. However, the oak-hardwood forests and freshwater aquatic habitats are becoming less available for mammals on Hilton Head at this time. This is because upland hardwood forests are generally prime areas for development and freshwater aquatic habitats are rather limited in extent and are susceptible to water pollution. Other island habitats are less endangered, as dune/beach and saltmarsh habitats are protected by government regulations and seral habitats are abundant on Hilton Head.

Population estimates of the more common, larger mammals found on Hilton Head are given in Table II-I-8. Jenkins obtained these estimates from studies on Hilton Head Plantation in 1972, when this was an excellent wild area with the best potential for wildlife left on the island. It is probable that these estimates are higher than existing populations on the island as a whole, because this area contained more prime mammal habitat than other parts of Hilton Head and has since undergone real estate development.

The importance of predation to the mammal populations of an island should be emphasized. Because of the limited areal extent of an island such as Hilton Head, and hindrances preventing emigration, overpopulation can sometimes be a problem. When predators have been reduced or eliminated, many mammal populations can reproduce until their habitats are depleted of food sources; increased mortalities eventually result from disease and starvation. Therefore, it is particularly important on an island such as Hilton Head to preserve natural predators such as bobcats,

TABLE II-I-8

POPULATION ESTIMATES OF COMMON MAMMAL SPECIES ON HILTON HEAD ISLAND*

Common Name	Numbers/mile^2
Gray Squirrel	1000
Raccoon	60
Marsh Rabbit	50
White-tailed Deer	30
Oppossum	20
Mink	15
Otter	5
Bobcat	3

*Table derived from Jenkins (1972). Estimates obtained from studies of the Hilton Head Plantation (4000 acres) in 1972.

minks, and snakes to control populations of rodents, rabbits, and other small mammals. Large herbivores, such as deer, can only be controlled by hunting since their natural predators (cougars, bears) are no longer present on the island. On the coastal islands of Georgia, managed hunts are conducted from time to time for the expressed purpose of controlling deer herds.

Mention should be made of rabies among island mammal populations. Rabies has been increasing in Beaufort County and on Hilton Head within the last two years (Hopkins 1979). Raccoons have been the most commonly infected animals.

Of the eight endangered mammal species possibly occurring in South Carolina (See Table II-I-6), none are known to presently exist on Hilton Head. The presence of the cougar is extremely doubtful, as they mostly inhabit wilderness areas (Burt & Grossenheider 1976). There have been no verified sightings in South Carolina for years (Sanders 1978). Manatees are of possible occurrence in the tidal creeks of Hilton Head during warmer months, and have been occasionally spotted in the marine waters of Beaufort County (Jenkins 1972, Sanders 1978). The six endangered species of whales would be very unlikely to occur on Hilton Head unless they were stranded on beaches, which does happen on rare occasions. Sperm whales have been reported in the coastal waters of Beaufort County (Sanders 1978).

Two of the mammals found on Hilton Head are considered by authorities to be unique subspecies, although they are not legally protected.

The Hilton Head Island raccoon (Procyon lotor solutus) is a "small gray raccoon with an intense black mask" (Jenkins 1972). Jenkins (1972) states that this raccoon is known only from Hilton Head Island, but Sanders (1978) considers the subspecies to be statewide. The Hilton Head Island white-tailed deer (Odocoileus virginianus hiltonensis) is a "small deer with darkly colored tarsal glands and with a highly arched and narrow brain case" (Jenkins 1972). Authorities agree that this distinct variety is known only from Hilton Head Island, and Jenkins (1972) recommends that efforts be made to maintain the uniqueness of this population by preventing the stocking of outside deer populations. From the population estimates given in Table II-I-8, it would appear that neither the Hilton Head raccoons nor deer were in danger of extirpation in 1972. Raccoons should still be plentiful as they are very adaptive to man-made influences. However, the destruction of important mammal habitats by island developments could have had a detrimental effect on deer populations in recent years (Hopkins 1979). Jenkins (1972) stated that with adequate continuous cover and swamp these deer could coexist on the island with the relatively large human and dog populations.

Amphibians and Reptiles

Although relatively little herpetological field work has been conducted specifically in the coastal zone of South Carolina, it is considered to be the richest and most diverse section of the state, especially with regard to turtles, snakes and frogs (Harrison 1978). The 45 species of amphibians and 64 species of native reptiles known from the coastal zone are listed in Appendix II-I-3. Twenty-seven (60 percent) of these amphibian species and twenty-one (32 percent) of these reptile species have also been collected in Beaufort County; these figures are probably misleading with respect to reptiles. Records indicate that amphibians have been well-collected in Beaufort County, whereas little reptilian study appears to have been done there.

Verified records for Hilton Head Island include seven species of amphibians and five species of reptiles. These records are very incomplete and probably are quite low for both groups, particularly the reptiles. Studies on other coastal islands have shown that usually less than half the number of herpetofauna species have been found on islands compared to their closest mainland areas (Gibbons and Harrison 1975). A total of 30 non-marine species of reptiles and amphibians were found in detailed investigations of Kiawah Island, South Carolina (30 percent of adjacent mainland), and 52 species of herpetofauna were found in studies of Cumberland Island, Georgia (51 percent of adjacent mainland)(Gibbons and Harrison 1975; Hillestad, et.al. 1975). These studies also revealed that reptilian species are much more numerous than amphibians on these islands. Species of reptiles outnumbered amphibian species by three to one (21 : 7) on Kiawah Island and almost two to one (34 : 18) on Cumberland Island. This trend can be expected to hold true for Hilton Head Island as well, since most reptilian species are better adapted for movement across the marshes and estuaries. Of the amphibians found on the coastal islands, salt water resistant species of frogs and toads predominate (Johnson, et.al. 1974).

Species of salamanders are relatively scarce, presumably reflecting a lesser tolerance to salt water.

With regard to habitat requirements, reptiles and amphibians have similar needs compared to other animal groups. Table II-I-9 lists the relative importance of various habitat types to the herpetofauna studied on Kiawah Island. As seen from this table, freshwater aquatic and forest habitats are especially important to reptiles and amphibians.

Of the South Carolian coastal herpetofauna six species are considered endangered or threatened by the U. S. Fish and Wildlife Service. (See Table II-I-6). All of these species are reptiles, and are discussed below.

Alligators are generally found in freshwater aquatic habitats (swamps, marshes, ponds) and are presently quite common on Hilton Head Island (Hopkins 1979). Alligators are so numerous that they are considered a nuisance by some island residents (Hopkins 1979); their future security depends on the preservation and lack of contamination of freshwater aquatic habitats.

The indigo snake is typically found in sand hill communities of the southeastern coastal plan (Odom, et.al. 1977). The presence of this snake on Hilton Head is very doubtful, as it has not been reported from South Carolina since 1907 (Gibbons 1975).

The other four threatened or endangered reptiles are all marine sea turtles, which spend most of their life cycles in the ocean. They commonly come ashore only during nesting periods when they climb onto coastal beaches to rest on the upper shores and primary dunes. Of these sea turtles, only the Loggerhead turtle commonly nests on the South Carolina coast. The other three species are only rarely seen in offshore waters, although there have been reports of Green turtles nesting in earlier times (Gibbons 1978).

Loggerhead turtles are known to occur presently on Hilton Head, with possibly a dozen females still nesting on the island's beaches (Hopkins 1979). Nesting may occur 2 to 6 times per female in a season (generally late May to mid-August), with an average of 125 eggs to a clutch (Dean and Talbert 1975). However, mortality is generally quite high (80 - 100 percent), with nests most frequently being destroyed by raccoons, humans, feral hogs, and high storm waters. Additionally, hatchling turtles may be disoriented by lights and noises near developed beaches and subsequently die from dessication before they reach ocean waters. Although there are loggerhead turtle rookeries on many of the southeastern coastal islands, few of them are large and many have been reduced or eliminated in recent years. Efforts should be made to encourage nesting on any of these coastal islands as the future of this species is very much in jeopardy. Jenkins (1972) has recommended maintaining the northern tip of Hilton Head beach as a loggerhead hatchery.

TABLE II-I-9

RELATIVE IMPORTANCE OF HABITATS FOR REPTILES AND AMPHIBIANS

1. Freshwater ponds and margins
2. All forest types
3. Maritime thickets
4. Exposed dune areas
5. Salt marshes
6. Tidal creeks
7. Open beach

Source: Gibbons and Harrison (1975)

AQUATIC COMMUNITIES

The aquatic communities of a coastal island and the surrounding water bodies reflect an extreme range of environmental conditions. While isolated freshwater ponds occur on coastal islands, brackish, tidal waters are much more common and have been subjected to more intense research.

The communities in the Hilton Head area can be described as estuarine. A large number of classification systems have been developed to describe estuaries. These include a functional classification (Odum et.al., 1974); a geomorphological classification (Pritchard, 1967); a geographic classification (Day, 1964); and a chemical-physical classification (symposium on the Classification of Brackish waters, 1959). The chemical-physical (Venice) system is based on salinity ranges (Table II-I-10). This system defines the physical boundaries for an estuarine system but does not effectively separate the aquatic communities. An ecological classification has been proposed (Carriker, 1967) which describes components of the aquatic community according to their range of salinity tolerance (Table II-I-11). These last two classification systems are probably the most widely used systems at this time.

It is not the purpose of this report to fully define or describe the estuarine systems of the Hilton Head Island area. Instead, this report will outline general aspects of the aquatic systems and include specific information available for the study area. This information has been organized into four sections: a general summary of estuarine systems,

TABLE II-I-10

THE VENICE SYSTEM OF ESTUARINE CLASSIFICATION
(SYMPOSIUM ON THE CLASSIFICATION OF BRACKISH WATERS, 1975)

Limnetic	salinity range - 0.5^{o}/oo*, refers to freshwater area of river and those organisms restricted to that area.
Oligohaline	salinity range 0.5 - 5.0^{o}/oo, refers to head of estuary where spring tides may cause maximum salinities of 5.0^{o}/oo and those organisms restricted to this transition zone.
Mesohaline	salinity range 5.0 - $18.^{o}$/oo, refers to the upper reaches of estuaries and organisms normally found in these salinity ranges.
Polyhaline	salinity range 18.0 - 30.0^{o}/oo, refers to the middle and lower reaches of estuaries and those organisms normally associated with these salinities.
Euhaline	salinity range - 30^{o}/oo, refers to river mouth and organisms associated with neritic (near shore) waters.

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*^{o}/oo: part per thousand

TABLE II-I-11

AN ECOLOGICAL SYSTEM OF ESTUARINE CLASSIFICATION
(CARRIKER, 1967)

Mixohaline	refers to organisms found throughout the salinity ranges outlined by the Venice System (i.e., from limnetic to euhaline).
True Estuarine	refers to species restricted to estuaries and occurring in neither the sea nor freshwater.
Stenohaline marine	refers to organisms restricted to salinities greater than 25^{o}/oo* usually inhabiting open seashores and river mouths.
Euryhaline marine	refers to marine organisms which can tolerate salinities as low as 5.0^{o}/oo. These species occupy all estuarine zones below the head and are the most ubiquitous estuarine organisms.
Migrant	refers to euryhaline species which spend only part of their lives in estuaries.

---

*^{o}/oo: part per thousand

a description of the benthic community, a description of the nektonic community, and a description of the planktonic and periphytic communities.

Estuarine Systems

An estuary may be described as a semi-enclosed coastal body of water with a free connection to the ocean. An estuary, therefore, is an area subject to tidal action and is a mixing zone for sea water and fresh water. An estuary can include tidal creeks, coastal sounds and bays, river mouths and tidal marshes.

The estuarine ecosystem can be described by its energetics. Primary production in estuaries originates in three major areas: the macrophytic, rooted marsh vegetation; the periphytic algae attached to those plants; and other solid substrates and the free floating phytoplankton. While the relative importance of these three sources has been found to be variable (Odum, 1971; Pomeroy, 1959; Zingmark, 1975), together they constitute the energy source for the highly productive estuarine systems. This high level of productivity is maintained by the photosynthetic activity of these populations and the energy subsidy provided by the tidal action.

The high level of primary productivity (phytosynthesis) is associated with high levels of secondary productivity from consumers. This high level of secondary productivity is the basis of the extensive coastal and marine fisheries. A dynamic view of the interactions in an estuarine system is presented by the life histories of several seafood species. For example, several species of commercially important shrimp live and spawn offshore. The larvae of these species develop in the shallow bays, marshes, and creeks before migrating back to deeper water. The estuary is not only the food source for the adults, but provides both food and habitat for the juvenile and adolescent forms.

Odum (1971) has associated the high level of production found in estuaries with three factors. An estuary acts as a nutrient trap, retaining nutrient input from primary production and recycling this production through the bottom sediments. The producers associated with estuaries (rooted macrophytes, periphytic species, phytoplankon) are diverse enough that primary productivity occurs throughout most of the year. The final factor involves the energy subsidy of tidal action. The physical transport of nutrients and wastes to and from the estuary by tidal action facilitates a more efficient use of metabolic systems.

The ecological classification of Carriker (Table 10-B) emphasizes another important aspect of estuarine communities. These communities include not only true estuarine species, but a wide range of species from limnetic or freshwater species to stenohaline and migrant species. The overlapping tolerances of these species are reflected in the high diversity of some estuarine areas.

Estuaries are used as breeding grounds by a number of species including many of commercial value. The life cycle component of each species is an important consideration in the assessment of environmental impacts. The changes in behavior (benthic - planktonic - benthic) and habitat requirements for a given species over its life history render each species subject to a wide range of perturbations.

In the following sections, major components of the estuarine community are inventoried. These sections include the benthic, nektonic, and planktonic and epiphytic species. This division is somewhat artificial since many benthic and nektonic species have planktonic life forms. The inventories have been largely drawn from selected studies. Extensive species lists are not reproduced from these works although shorter summary lists are included. The most complete checklist for the biota of the South Carolina Coastal Zone is that of Zingmark (1978). While this list is not inclusive, it represents the most current summary of coastal biota. Extensive species list would be redundant in light of this general work.

More specific information has been drawn from several other studies (Lear and Smith, 1972; Shealy, 1974; Windom 1973; Andrews and Kendall, 1979). The summary tables from these works indicate actual conditions within the study area.

Benthic Communities

The major emphasis of benthic studies in the Hilton Head Island area, as well as for the coast of South Carolina, has been focused on commercially valuable species (i.e., clams and oysters). The economic value of these species as well as their distribution and abundance in the study area have been discussed elsewhere (Chapter III-F). This section will therefore be restricted in its consideration of these species.

Anderson, et al. (1978) have surveyed the extent of hard clam resources in the Hilton Head area (Mercenaria mercenaria and M. campechiensis). Their results for sample sites near the Hilton Head area are summarized in Table II-I-12. Their findings indicate that shell-containing benthic areas contain significantly greater concentrations of clams than do sand areas. This bottom type in turn supports significantly greater populations than mud habitat. The extent and utilization of the oyster populations in the study area are much more extensive, as indicated in the Natural Resource Section.

The benthic community is an extremely important component in estuarine ecosystems. The processing of plant material by the benthic community and its utilization as a food resource are important in estuarine trophic dynamics. The presence and distribution of the low mobility, benthic communities are controlled by environmental factors such as sediment type, hydrographic regime and water quality. Holland, et. al. (1973) have found the benthic community structure to be a good monitor and indicator of environmental conditions. A detailed data base of benthic community structure would be invaluable in the Hilton Head Island area for future use in environmental monitoring.

TABLE II-I-12

RESULTS OF CLAM SAMPLING IN THE HILTON HEAD EIS STUDY AREA

(AFTER ANDERSON ET AL., 1978)

LOCATION	SAMPLES	SAMPLES CONTAINING 1 OR MORE CLAMS	PERCENT CONTAINING CLAMS	ESTIMATED ACRES OF CLAM BOTTOMS*
Port Royal Sound	2,993	52	1.7	104
Broad Creek	821	8	1.0	525
Mackay Creek	600	0	0.0	0
May River	302	0	0.0	0
Calibogue Sound	644	0	0.0	0
TOTAL	5,360	60	1.1	629

*Acreage was determined by planimetry of areas where clams were found.

Three major studies of benthic communities are available for the South Carolina coast. The Port Royal Sound area has been studied by Parrish (1972). Kiawah Island has been inventoried (E.R.C., 1975), and the North Inlet area in Georgetown County has been studied (Holland, 1974). In addition, a general checklist for the benthic community has been summarized (Zingmark, 1978). While these studies provide background data for probable species presence, they are inadequate for an accurate description of the Hilton Head sites. Holland's (1974) data are restricted to sand and mud bars exclusively. Utilization of the Port Royal data (Parrish, 1972) is limited by the level of taxonomic identification (genus level). The sensitivity of benthic communities to environmental disturbances severely limits the use of generalized data (Kaplan, et.al., 1974).

Benthic community studies which are site specific to Hilton Head Island have primarily been associated with the Folly area (Windom, 1973; Andrews and Kendall, 1979). The first of these studies (Windom, 1973) limited sampling of the benthic community in the marsh adjacent to Singleton Beach and in the lagoon system of Palmetto Dunes Plantation. The sampling was qualitative in nature, and taxonomic identification was non-specific. Collected species included *Pseudohaustorius borealis* and *Ilyanassa obsoleta* along with unidentified oliyochaete annelids and a nereid polychaete. These data are too limited to produce meaningful conclusions. The second Folly study (Andrews and Kendall, 1979) included sampling in Folly Creek, Palmetto Dunes lagoon system, and Broad Creek. This sampling was quantitative and the taxonomic identification was more specific. A larger number of species was collected in this study (Table II-I-13). The faunal list, species diversity and density were typical of salt marsh ecosystems (Kendall, 1974).

Nektonic Community

The nektonic community consists of highly mobile or "swimming" species and includes fish, crabs, and shrimp. The nature and extent of the crab (Callinectes sapidus) and shrimp (Paeneus setifarus and (P. aztecus) are discussed in the Natural Resource Section. Data on these species and the nektonic community are available from several sources. The Port Royal Sound Environmental Study (1972) and the Bottom Trawl Study (Shealy, 1974) contain information specific to the Hilton Head Island. Comparative information from Kiawah Island is reported by Dean (1975). A summary of information on the Georgia coast has been published by Johnson, et.al.(1974). Additional site specific information is available for the Folly area (Windom, 1973; Andrews and Kendall, 1979). Information on the nektonic community of the Hilton Head Island EIS study area is summarized in Table II-I-14. The species collected include several species of commercial and sport fishing importance. The composition of this community is fairly typical of estuarine systems in South Carolina and Georgia. Both juvenile and adult forms of several species were collected in these studies, emphasizing the importance of the salt marsh-estuary system as a nursery area.

Planktonic and Periphyton Communities

The planktonic community consists of floating organisms whose

TABLE II-I-13

MACROINVERTEBRATES COLLECTED OR OBSERVED IN FOLLY CREEK, PALMETTO DUNES LAGOON SYSTEM, AND BROAD CREEK DURING THE STUDY PERIOD (ANDREWS AND KENDALL, 1979).

	FOLLY CREEK MARSH SYSTEM				
	Creek	Marsh	Palmetto Dunes Canal	Broad Creek	Verification
CNIDARIA:					
Unidentified anemone	C		C		O
CTENOPHORA:					
Mnemiopsis sp.	C			C	S
BRYOZOA:					
Membranipora sp.			C		O
filamentous sp.	VN				O
RHYNCOCOELIA:					
Tubulanus pellucidus	C		C		G
POLYCHAETA:					
Glycera americana				R	G
Nereis succinea	C		R	C	G, O

TABLE II-I-13 (cont'd)

Lumbrineris bassi	VN				G, O
Haploscoloplos fragilis	C			C	G
Heteromastus filiformis	VN		C	N	G
Paraprionospio pinnata	R			R	G
Spiochaetopterus oculatus	C		C		G, O
Pista palmata	R				G
Hydroides parva			C		O
GASTROPOD:					
Ilyanassa obsoleta	VN		C	VN	G, O
Littorina irrorata		N			O
BIVALVIA:					
Macoma balthica	R				G
Macoma phenax				R	G
Petrichola pholadiformis	N				O
Barnea truncata	N				G, O
Mercenaria campechiensis	C		C		G, O
Crassostrea virginica	VN	C	N	VN	G, O

TABLE II-I-13 (cont'd)

Modiolns demissus	R	C		C	0
Brachidonotes recurvus	R			C	0
CRUSTACEA:					
Balanus eburneus	N		N	N	0
Gammarid amphipod (sp. 1)	R				
Gammarid amphipod (sp. 2)					
Pseudohaustorius carolieniensis	VN				G
Acarthohaustorius millsi	R				G
Palaemonetes vulgaris	VN		VN	VN	G, 0, S
Upogebia affinis	R				G
Callianasa sp.	R				0
Panopeus herbsti	C				G, 0
Eurypanopeus depressus	C				G
Uca pugnax	R	VN		VN	G, 0
Uca pugilator	R	VN	C	C	0
Callinectes sapidus	VN		VN	VN	G, S, 0

TABLE II-I-13 (cont'd)

Pagurus pubescens	C	0
Pagurus longicarpus	C	0

Legend: VN = very numerous
N = numerous
C = common
R = rare
O = direct observation
S = seine
G = grab

TABLE II-I-14

NEKTONIC SPECIES COLLECTED FROM SEVERAL STUDIES IN THE HILTON HEAD ISLAND E.I.S. STUDY AREA

	Port Royal Sound*1	Cali-bogue Sound*1	Folly Study (1973)*2	Folly Study (1979)*3
Amaroucium sp. - Sea Pork	X			
Anchoa hepsetus - Striped Anchovy		X		
Anchoa mitchilli - Bay Anchovy	X	X	X	
Archosargus probatocephalus - Sheepshead				X
Arius felis - Sea Catfish	X	X	X	
Asterias forbesi - Common Starfish	X	X		
Bairdella chrysura - Silver Perch	X	X	X	
Bougainvillia rugosa - Jellyfish Spp.	X	X		
Brevoortia tyrannus - Atlantic Menhaden	X	X		X
Callinectes ornatus - Swimming Crab	X			
Callinectes sapidus - Blue Crab	X	X	X	X
Cancer irroratus - Common Rock Crab	X	X		
Centropristis philadelphica - Sea Bass Spp.	X			
Centrophristis striata - Black Sea Bass	X			
Chaetobipterus faber - Atlantic Spadefish	X			
Chilomycterus schoepfi - Striped Burrfish		X		
Chiropsalmus quadrimanus - Jellyfish Spp.	X			
Chloroscombrus chrysura - Bumper	X	X		
Cyanea capillata - Pink-Jellyfish	X			
Cynoscion nebulosus - Spotted Seatrout		X		X
Cynoscion regalis - Weakfish	X	X		
Cyprinodon variegatus - Broad Killifish				X
Dorosoma petense - Shad Spp.	X			
Eucinostomus argenteus - Spotfin mojarra			X	
Fundulus heteroclitus - Mummichog			X	X
Fundulus majalis - Striped Killifish			X	X
Gobionellus stigmaticus - Spotted Goby	X			
Gobiosoma boschi - Goby				X
Hexapanopeus angustifrons - Mud Crab	X	X		
Hypsublennius nentzi - Feather Blenny	X			
Lagodon rhomboides - Pinfish			X	X
Larimus fasciatus - Banded Drum		X		X
Leiostomus xanthurus - Spot	X	X	X	
Loiguncula brevis - Squid	X	X		
Luida clathrata - Starfish		X		
Menidia menidia - Atlantic silverside			X	X
Menippe mercenaria - Stone Crab		X		
Menticirrhus amer. - Sand Whiting	X			
Micropogon undulatus - Atlantic Croaker	X	X		X
Monacanthus hispidos - Planehead filefish	X	X		
Mugil cephalus - Stripped mullet			X	X
Mugil curema - White mullet			X	X
Myrophis punctatus - Speckled worm eel				X
Neopanope sayi - Mud Crab	X	X		

TABLE II-I-14 (cont'd)

	Port Royal Sound*1	Cali-bogue Sound*1	Folly Study (1973)*2	Folly Study (1979)*3
Ovalipes ocellatus - Lady Crab	X			
Pagurus defensus - Hermit Crab		X		
Pagurus longicarpus - Common Hermit Crab	X	X		
Palaemontes pugio - Grass Shrimp	X			
Palaemontes vulgaris - Common Prawn	X	X	X	
Paralichthys dentatus - Summer Flounder	X	X		X
Penopeus herbstii - Mud Crab	X			
Penaeus aztecus - Brown Shrimp	X	X		
Penaeus setiferus - White Shrimp	X	X	X	
Peprilus allepidotus - Southern Harvest Fish		X		
Pomatomus saliatrix - Bluefish		X		
Portunus gibbesii - Swimming Crab	X	X		
Portunus spinimanus - Swimming Crab	X	X		
Prionotus carolinus - Northern Sea Robin	X			
Prionotus evolans - Sea Robin Spp.		X		
Rhopilema verrilli - Jellyfish	X			
Rissola marginata - Striped Cusk-eel	X			
Renilla reniformis - Sea Pansy		X	X	
Sciaenops ocellata - Red Drum			X	
Selene vomer - Lookdown		X		
Squilla empusa - Mantis Shrimp	X	X		
Stellifer lanceolatus - Star Drum	X	X		
Sphyrna zygaena - Hammerhead Shark Spp.		X		
Stomoluphus meleagris - Many-mouthed Sea Jelly	X			
Symphurus plagiusa - Black Cheek Tongue Fish	X	X	X	X
Trachinotus carolinas - Common Pompano			X	
Tranchypeneus constrictus - Shrimp Spp.	X	X		
Trichiurus lepturus - Atlantic Cutlass Fish	X	X		
Trinectes maculatus - American Sole	X	X		
Urophycis regius - Spotted Hake	X			
Vomer setapinnus - Atlantic Moonfish		X		

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*1Shealy, M.H. 1974. Bottom Trawl Data from South Carolina Estuarine Survey Cruises, 1973.

*2Windom, H.L. 1973. Environmental Impact Statement for Closing the Folly.

*3Andrews, J.W. and D.R. Kendall. 1979. Environmental Impact of Closing Folly Creek.

movements are controlled by water currents. The periphyton community as defined by Odum (1971) consists of organisms (both plant and animal) which are attached to solid surfaces projecting above the bottom.

The two communities are considered together for several reasons. Both communities are important in the energetics of the estuarine system as previously discussed. In addition, both communities can be used as indicators or monitors of pollution and stress. However, there is very little information available for these two communities for the Hilton Head area. A general description of these communities is presented in several references (Ketchum, 1967; Lauff, 1967; McHugh, 1967), and a checklist of the communities for the coastal zone of South Carolina has been published (Zingmark, 1978). However, specific studies of seasonal succession, species diversity, and environmental impacts are inadequate for the study area.

Studies which are more localized to the study area include work done at Cape Fear, N. C. (Carpenter, 1971), Georgetown County, S. C. (Jacobs, 1971), Kiawah Island, S. C. (Zingmark, 1975) and Port Royal Sound, S. C. (Lear and Smith, 1972). However, there is a wide range of taxonomic reliability, specificity, and adequacy of sample design among these reports. The more remote studies (Carpenter, 1971; Zingmark, 1975) present the most detailed and reliable data. Jacobs (1971) considered the freshwater algae and contributed a preliminary listing of species without associated environmental parameters. Freshwater work is supplemented by the surveys of North Carolina phytoplankton by Whitford (1958) and Whitford and Schumacher (1973).

The only planktonic and periphytic data available for the Hilton Head Island study area are for Port Royal Sound (Lear and Smith, 1972; Blackwelder, 1972). The major limitation of the data reported in this study is the level of taxonomic enumeration. Most taxa are only identified to the generic level in the plankton study. The general composition of these communities can be drawn from the tabular summary of phytoplankton and epiphytic algae (Tables II-I-15 and II-I-16).

TABLE II-I-15

PHYTOPLANKTON FROM A STUDY OF PORT ROYAL SOUND
(LEAR AND SMITH, 1972)

- Diatoms (Chrysophyta)
  - Centrate
    - Chaetoceros compressus
    - Chaetoceros gracilis
    - Chaetoceros subtilis
    - Cyclotella
    - Diatoma
    - Leptocylindras
    - Rhizosolenia
    - Skeletonenia
    - Stephanopyxis
- Pennate
    - Asterionella
    - Fragilaria
    - Gyrosigma
    - Meridion
    - Navicula
    - Nitzschia sp.
    - Raphoneis
    - Synedra
    - Tabellaria
    - Thalassiothrix

- Flagellates
  - Amphidinium
  - Desmidium
  - Exuviella
  - Euglena

TABLE II-I-16
EPIPHYTIC ALGAE FROM A STUDY OF PORT ROYAL SOUND (BLACKWELDER, 1972)

CYANOPHYTA (Blue-green Algae) (on Spartina)
- Microcoleus lyngbyaceus
- M. chthonoplastis
- Schizothrix arenaria
- S. mexicana
- S. calicola
- Oscillatoria lutea
- O. princeps
- O. submembranacea
- Porphyrosiphon Notarisii
- P. Kurzii
- P. miniatus
- Entophysalis conferta
- Arthrospira brevis
  - (on shells)
- Entophysalis deusta
- Schizothrix calicola
- Anacystis sp.
- Calothrix sp.
  - (on mud)
- Arthrospira brevis

RHODOPHYTA (Red Algae) (on Spartina)
- Bostrychia rivularis
- Calloglossa leprieurii
- Erythrotrichia carnea
  - (on shells)
- none
  - (on mud)
- Gracilaria verrucosa
- Polysiphonia denudata
- P. fibrillosa

CHLOROPHYTA (Green Algae) (on Spartina)
- Chaetomorpha minima
- Ulva lactuca
- Cladophora frascatii
- Enteromorpha sp.
  - (on shells)
- none
  - (on mud)
- Ulva lactuca

APPENDICES

APPENDIX II-I-1

CHECKLIST OF BIRDS KNOWN FROM THE COASTAL ZONE OF SOUTH CAROLINA

Key to abbreviations used in Table.

Abundance

C - Common, seen in good numbers in appropriate habitat and season.

FC - Fairly common, seen in moderate numbers in appropriate habitat and season.

U - Uncommon, seen in small numbers and/or not seen every time in appropriate habitat and season.

R - Rare, seen in small numbers, between five and and records over the past twenty years.

AC - Accidental, outside normal range, only one to five records for the past twenty years.

EX - Extinct.

XP - Extirpated or believed to be extinct in this part of the species range.

Seasonal Occurrence

PR - Permanent resident, present year round.

SR - Summer resident, breeds.

SV - Summer visitor, but does not breed.

WV - Winter visitor.

M - Migrant, transient.

*Has been sighted on Hilton Head Island by the Audubon Society (1960 - 1974).

APPENDIX II-I-1

CHECKLIST OF BIRDS KNOWN FROM THE COASTAL ZONE OF SOUTH CAROLINA

			PREFERRED HABITAT				
	Abundance	Seasonal Occurrence	Shore	Forests	Feral	Freshwater	Estuarine
Order Gaviiformes (Loons)							
* Gavia immer. Common Loon	C	WV	X				X
* G. stellata. Red-throated Loon	FC	WV	X				X
Order Podicipediformes (Grebes)							
* Podiceps grisegena. Red-necked Grebe	R	WV					X
* P. auritus. Horned Grebe	C	WV					X
P. nigricollis. Eared Grebe	AC	--				X	X
Aechmophorus accidentalis. Western Grebe	AC	--				X	X
* Podilymbus podiceps. Pied-billed Grebe	C	PR				X	X
Order Procellariiformes (Tubenosed Swimmers)							
Puffinus diomedea. Cory's Shearwater	U	SV	X				
P. gravis. Greater Shearwater	FC	SV	X				
P. griseus. Sooty Shearwater	U	SV	X				
P. assimilis. Little Shearwater	AC	--	X				
P. iherminieri. Audubon's Shearwater	U	SV	X				
Oceanodroma levcorhoa. Leach's Storm-Petrel	AC	--	X				
O. castro. Harcourt's Storm-Petrel	AC	--	X				
* Oceanites oceanicus. Wilson's Storm-Petrel	FC	SV	X				
Order Pelecaniformes - (Tropicbirds, Pelicans, & Allies)							
Pelecanus erythrorhynchos. White Pelican	R	WV	X				X
* P. occidentalis. Brown Pelican	FC	PR					X
Sula dactylatra. Blue-faced Booby	AC	--	X				
S. leucogaster. Brown Booby	AC	--	X				
* Morus bassanus. Gannet	FC	WV	X				
Phalacrocorax carbo. Great Cormorant	R	WV					X
* Phalacrocorax auritus. Double-crested Cormorant	C	PR					X
* Anhinga anhinga. Anhinga	C	PR				X	
* Fregata magnigicens. Magnificent Frigate-bird	C	PR					X
Order Ciconiiformes (Herons, Storks, Ibises, & Allies)							
* Ardea herodias. Great Blue Heron	C	PR					X
* Butorides striatus. Green Heron	C	PR				X	
* Florida caerulea. Little Blue Heron	C	PR				X	X
* Bubulous ibis. Cattle Egret	C	PR			X		
* Dichromanassa rufescens. Reddish Egret	AC	--					X
* Cosmerodius albus. Great Egret	C	PR	X			X	X
* Egretta thula. Snowy Egret	C	PR	X			X	X
* Hydranassa tricolor. Louisiana Heron	C	PR				X	X

APPENDIX II-I-1
(cont'd)

	Abundance	Seasonal Occurrence	Shore	Forests	Feral	Freshwater	Estuarine
Order Falconiformes. (Vultures, Hawks, Falcons, Kites)							
* Cothartes aura. Turkey Vulture	C	PR	X	X	X		
* Coragypo atratus. Black Vulture	C	PR	X	X	X		
Elanus leucurus. White-tailed Kite	AC	--			X		
* Elanoides forticatus. Swallow-tailed Kite	U	SR		X	X		
Ictinia mississippiensis. Mississippi Kite	FC	SR			X		
* Accipiter striatus. Sharp-skinned Hawk	FC	PR		X			
* A. cooperii. Cooper's Hawk	FC	PR		X			
* Buteo jamaicensis. Red-tailed Hawk	FC	PR			X		
* B. lineatus. Red-shouldered Hawk	C	PR		X	X		
* B. platypterus. Broad-winged Hawk	U	PR		X			
B. swainsoni. Swainson's Hawk	AC	--		X	X		
* B. lagopus. Rough-legged Hawk	R	WV			X		
Aquila chrysaetos. Golden Eagle	R	WV			X		
* Haliaetus leucocephalus. Bald Eagle	U	PR		X	X		
* Circus cyaneus. Marsh Hawk	C	PR			X	X	X
* Pandion haliaetus. Osprey	U	PR				X	X
* Falco peregrinus. Peregrine Falcon	U	WV	X	X	X	X	
* F. columbarius. Merlin	U	WV	X		X		
* F. sparverius. American Kestrel	C	WV			X		
Order Galliformes. (Grouse, Quail, Turkeys)							
Bonasa umbellus. Ruffed Grouse	AC	--		X			
* Colinus virginianus. Bob White	C	PR			X		
* Meleagris gallopavo. Turkey	U	PR		X	X		
Order Fruiformes. (Cranes, Rails, & Allies)							
Grus americana. Whooping Crane	XP	--			X		
Grus canadensio. Sandhill Crane	R	WV			X	X	
Aramus guarinuna. Limpkin	AC	--				X	
* Rallus elegans. King Rail	FC	PR				X	
* R. longirostris. Clapper Rail	C	PR					X
* R. limicola. Virginia Rail	FC	WV				X	X
* Porzana carolina. Sora	FC	WV				X	X
Coturnicups noveboracensis. Yellow Rail	R	WV			X	X	X
Laterallus jamaicensis. Black Rail	R	SR					X
* Porphyrula martinica. Purple Callinule	FC	SR				X	
* Gallinula chloropus. Common Gallinule	C	PR				X	
* Fulica americana. American Coot	C	PR				X	X
Order Charadriiformes. (Shorebirds, Gulls, Terns, Auks)							
* Haematopus palliatus. American Oyster-catcher	FC	PR	X				X
Vanellus vanellus. Lapwing	AC	--			X		
* Charadrius semipalmatus. Semipalmated Plover	C	PR	X				
* C. melodus. Piping Plover	FC	WV	X				
* C. wilsonia. Wilson's Plover	C	SR	X				
* C. vociferus. Killdeer	C	PR	X		X		
Pluvialis dominica. American Golden Plover	R	M	X				
* P. squatarola. Black-billed Plover	C	PR	X				
* Arenaria interpres. Ruddy Turnstone	C	PR	X				
* Philohela minor. American Woodcock	FC	PR		X	X		

APPENDIX II-I-1
(cont'd)

	Abundance	Seasonal Occurrence	Shore	Forests	Feral	Freshwater	Estuarine
* Nycticorax nycticorax. Black-crowned Night Heron	C	PR				X	X
* N. violacea. Yellow-crowned Night Heron	FC	PR				X	X
* Ixobrychus exilis. Least Bittern	FC	PR				X	
* Botaurus letiginosus. American Bittern	FC	PR				X	
* Myeteria americana. Wood Stork	FC	PR			X	X	
* Plegadis falcinellus. Glossy Ibis	FC	PR			X	X	X
* Eudocimus albus. White Ibis	C	PR			X	X	X
* Ajaja ajaja. Roseate Spoonbill	R	V				X	X
Phoenicopterus ruber. American Flamingo	AC	--					
Order Anseriformes (Swans, Geese, and Ducks)							
Cygnus olor. Mute Swan	AC	--				X	X
Olor columbianus. Whistling Swan	R	WV					X
* Bronta canadensis. Canada Goose	FC	WV			X	X	
B. bernicla. Brant	R	WV					X
Anser albifrons. White-fronted Goose	R	WV				X	X
* Chen caerulescens. Snow Goose	U	WV	X			X	
Dendrocygna bicolor. Fulvous Whistling Duck	R	WV	X				
* Anas platyrynchos. Mallard	C	WV				X	X
* A. rubripes. Black Duck	C	WV				X	X
* A. strepera. Gadwall	C	WV				X	X
* A. acuta. Pintail	C	WV				X	
* A. crecca. Green -winged Teal	C	WV				X	X
* A. discors. Blue-winged Teal	C	PR				X	X
A. cyanoptera. Cinnamon Teal	AC	--				X	
* A. penelope. European Wigeon	R	WV				X	
* A. americana. American Wigeon	C	WV				X	X
* A. clypeota. Shoveller	C	WV				X	
* Aix sponsa. Wood Duck	C	PR				X	
* Aythya americana. Redhead	U	WV					X
* A. collaris. Ring-necked Duck	C	WV				X	X
* A. valisineria. Canvasback	FC	WV					X
* A. marila. Greater Scaup	U	WV					X
* A. affinis. Lesser Scaup	C	WV				X	X
* Bucephala clangula. Common Goldeneye	FC	WV					X
* B. albeola. Bufflehead	C	WV					X
* Clangula hyemalis. Oldsquaw	U	WV					X
Histrionicus histrionicus. Harlequin Duck	AC	WV	X				
Somateria mollissima. Common Eider	R	WV	X				
S. spectabilis. King Eider	AC	WV					X
* Melanitta delandi. White-winged Scoter	U	WV	X				X
* M. perspicillata. Surf Scoter	FC	WV	X				X
* M. nigra. Black Scoter	C	WV	X				X
* Oxyura jamaicensis. Ruddy Duck	C	PR				X	X
* Lophodytes cucullatus. Hooded Merganser	C	WV					X
* Mergus merganser. Common Merganser	U	WV				X	X
* M. serrator. Red-breasted Merganser	C	WV				X	X

APPENDIX II-I-1
(cont'd)

	Abundance	Seasonal Occurrence	Shore	Forests	Feral	Freshwater	Estuarine
* Capella gallinago. Common Snipe	C	WV				X	X
* Numenius americanus. Long-billed Curlew	R	WV	X				
* N. phacopus. Whimbrel	C	M	X				X
N. borealis. Eskimo Curlew	XP	--					
* Batramia longicauda. Upland Sandpiper	R	M			X		
* Actitis macularia. Spotted Sandpiper	C	PR	X				
Tringa solitaria. Solitary Sandpiper	FC	M				X	
* T. melanoleucus. Greater Yellowlegs	C	PR	X			X	X
* T. flavipes. Lesser Yellowlegs	FC	WV				X	X
* Catoptrophorous semipalmatus. Willet	C	PR	X				X
* Calidris canutus. Red Knot	FC	WV	X				
* C. maritima. Purple Sandpiper	FC	WV	X				
C. melanotos. Pectoral Sandpiper	FC	M			X	X	
* C. fuscicollis. White-rumped Sandpiper	U	M	X				
C. bairdii. Baird's Sandpiper	R	M	X		X		
* C. minutilla. Least Sandpiper	C	PR	X				
* C. alpina. Dunlin	C	PR	X				
* C. pusillus. Semipalmated Sandpiper	U	M	X				
* C. mauri. Western Sandpiper	C	PR	X				
* C. alba. Sanderling	C	PR	X				
* Limnodromus griseus. Short-billed Dowitcher	C	PR	X				
* L. scolopaceus. Long-billed Dowitcher	AC	--	X			X	
Micropalama himantopus. Stilt Sandpiper	R	M	X			X	
Tryngites subruficollis. Buff-breasted Sandpiper	AC	--			X		
* Limosa fedora. Marbled Godwit	FC	WV	X				
L. haemastica. Hudsonian Godwit	AC	--	X				X
Philomachus pugnax. Ruff	AC	--					
* Recurvirostra americana. American Avocet	U	WV	X			X	
* Himantopus mexicanus. Black-necked Stilt	U	SR	X			X	
Phalaropus fulicarius. Red Phalarope	AC	--	X				
Steganopus tricolor. Wilson's Phalarope	R	M	X			X	
Lobipes lobatus. Northern Phalarope	R	M	X				
Stercocararius pomarinus. Pomarine Jaeger	AC	--	X				X
* S. marasiticus. Parasitic Jaeger	R	WV	X				X
S. longicaudus. Long-tailed Jaeger	AC	--	X				
Larus hyperboreus. Glaucous Gull	R	WV	X				
L. glaucoides. Iceland Gull	R	WV					X
* L. marinus. Great Black-backed Gull	U	WV					X
* L. argentatus. Herring Gull	C	PR	X				X
* L. delawarensis. Ring-billed Gull	C	PR					X
L. ridibundus. Black-headed Gull	R	WV	X				X
* L. atricilla. Laughing Gull	C	PR	X				X
* L. philadelphia. Bonaparte's Gull	C	WV	X				X
* Gelochelidon nilotica. Gull-billed Tern	FC	SR	X				X
* Sterna fosteri. Forster's Tern	C	PR	X				X
* S. hirundo. Common Tern	FC	PR	X				X
S. dougallii. Roseate Tern	R	M	X				
* S. fuscata. Sooty Tern	R	SV	X				
S. anaethetus. Bridled Tern	R	SV	X				
* S. albifrons. Least Tern	C	SR	X				X

APPENDIX II-I-1
(cont'd)

	Abundance	Seasonal Occurrence	Shore	Forests	Feral	Freshwater	Estuarine
* Sterna maximus. Royal Tern	C	PR	X				X
* S. sandvicensus. Sandwich Tern	FC	SR	X				X
* S. caspia. Caspian Tern	FC	PR	X				X
* Chlidonias niger. Black Tern	FC	SV	X			X	X
Anous stolidus. Noody Tern	R	SV	X				
* Rynchops nigra. Black Skimmer	C	PR	X				X
Pinguinus impennis. Great Auk	EX	--	X				
Alca torda. Razorbill	R	WV	X				
Uria lomvia. Thick-billed Murre	AC	WV	X				
Alle alle. Dovekie	R	WV	X				
Cepphus grylle. Black Guillemot	AC	WV	X				
Order Columbiformes (Doves and Pigeons)							
Columa livia. Rock Dove	C	PR			X		
* Zenaida asiotica. White-winged Dove	AC	WV			X		
* Z. macroura. Mourning Dove	C	PR			X		
Ectopistes migratoruis. Passenger Pigeon	EX	--		X			
* Columbina passerina. Ground Dove	C	PR			X		
Order Psittaciformes (Parrots and Allies)							
Conuropsis carolinensis. Carolina Parakeet	EX	--		X			
Order Cuculiformes (Cuckoos and Allies)							
* Coccyzus americanus. Yellow-billed Cuckoo	C	SR		X			
* C. erythropthalamus. Black-billed Cuckoo	U	M		X			
Order Strigiformes (Owls)							
Tyto alba. Barn Owl	U	PR			X		X
* Otus asio. Screech Owl	C	PR		X	X		
* Bubo virginianus. Great Horned Owl	FC	PR		X			
Nyctea scandiaca. Snowy Owl	R	WV			X		
Athene cunicularia. Burrowing Owl	AC	--			X		
* Strix varia. Barred Owl	C	PR		X			
Asio otus. Long-eared Owl	R	WV		X			
* A. flammeus. Short-eared Owl	FC	WV	X		X	X	
Aegolius acadicus. Saw-whet Owl	R	WV		X			
Order Caprimulgiformes (Goatsuckers)							
* Caprimulgus carolinensis. Chuck-Will's-Widow	C	SR		X	X		
* C. vociferus. Whip-poor-will	FC	WV		X			
* Cordeiles minor. Common Nighthawk	C	SR	X	X	X	X	X
Order Apodiformes (Swifts and Hummingbirds)							
* Chaetura pelagica. Chimney Swift	C	SR		X			
* Archilochus colubris. Ruby-throated Hummingbird	C	SR		X			
Selasphorus rufus. Rufous Hummingbird	AC	WV					
Order Coraciiformes (Kingfishers & Allies)							
* Megaceryle alcyon. Belted Kingfisher	C	PR				X	X

APPENDIX II-I-1
(cont'd)

	Abundance	Seasonal Occurrence	Shore	Forests	Feral	Freshwater	Estuarine
Order Piciformes (Woodpeckers & Allies)							
* Colaptes auratus. Common Flicker	C	PR		X			
* Dryocopus pileatus. Pileated Woodpecker	FC	PR		X			
* Melanerpes carolinus. Red-bellied Woodpecker	C	PR		X			
* M. erythrocephalus. Red-headed Woodpecker	FC	PR		X			
* Sphyrapicus varius. Yellow-bellied Sapsucker	FC	WV		X			
* Picoides villosus. Hairy Woodpecker	FC	PR		X			
* P. pubescens. Downy Woodpecker	C	PR		X			
* P. borealis. Red-cockaded Woodpecker	FC	PR		X			
Campephilus principalis. Ivory-billed Woodpecker	XP	--		X			
Order Passeriformes (Perching Birds)							
* Tyrannus tyrannus. Eastern Kingbird	C	SR			X		X
* T. dominicensis. Gray Kingbird	U	SV			X		X
* T. verticalis. Western Kingbird	U	WV			X		
Muscivora tyrannus. Fork-tailed Flycatcher	AC	--					
M. forficata. Scissor-tailed Flycatcher	R	WV	X		X		
* Myiarchus crinitus. Great Crested Flycatcher	C	SR		X			
* Sayornis phoebe. Eastern Phoebe	C	WV		X			
* Empidonax flaviventris. Yellow-bellied Flycatcher	AC	M		X			
* E. virescens. Acadian Flycatcher	C	SR		X			
E. minimus. Least Flycatcher	R	M			X		
* Contopus virens. Eastern Wood Pewee	C	SR		X			
Nuttallornis borealis. Olive-sided Flycatcher	AC	M	X		X		
Pyrocephalus rubinus. Vermilion Flycatcher	AC	WV				X	
Eremophila alpestris. Horned Lark	R	WV	X		X		
* Iridoprocne bicolor. Tree Swallow	C	WV				X	X
* Riparia riparia. Bank Swallow						X	X
* Stelgidopteryx ruficollis. Rough-winged Swallow	C	SR				X	X
* Hirundo rustica. Barn Swallow	C	PR				X	X
* Petrochelidon pyrrhonota. Cliff Swallow	U	M				X	X
* Progne subis. Purple Martin	C	SR		X		X	X
* Cyanocitta cristata. Blue Jay	C	PR		X			
Corvus corax. Common Raven	AC	WV					
* C. brachyrhychos. Common Crow	C	PR		X	X		
* C. ossifragus. Fish Crow	C	PR	X	X	X	X	X
* Parus carolinensis. Carolina Chickadee	C	PR		X			
* P. bicolor. Tufted Titmouse	C	PR			X		
* Sitta carolinensis. White-breasted Nuthatch	FC	PR		X			
* S. canadensis. Red-breasted Nuthatch	U	WV		X			
* S. pusilla. Brown-headed Nuthatch	C	PR		X			
* Certhia familiaris. Brown Creeper	FC	WV		X			
* Troglodytes aedon. House Wren	C	WV		X			
* T. troglodytes. Winter Wren	FC	WV		X			
Thryomanes bewickii. Bewick's Wren	R	WV			X		
* Thryothorus ludovicianus. Carolina Wren	C	PR		X			
* Cistothorus palustris. Long-billed Marsh Wren	C	PR				X	X
* C. platensis. Short-billed Marsh Wren	FC	WV			X		X
* Mimus polyglottos. Mockingbird	C	PR		X	X		
* Dumetella carolinensis. Catbird	FC	PR		X			

APPENDIX II-I-1
(cont'd)

	Abundance	Seasonal Occurrence	Shore	Forests	Feral	Freshwater	Estuarine
* Toxostoma rufum. Brown Thrasher	C	PR		X			
* Turdus migratorius. American Robin	C	WV		X	X		
* Hylocichla mustelina. Wood Thrush	C	SR		X			
Catharus guttatus. Hermit Thrush	C	WV		X			
* C. ustulatus. Swainson's Thrush	FC	M		X			
* C. minimus. Gray-checked Thrush	FC	M		X			
* C. fuscenscens. Veery	FC	M		X			
* Sialia sialis. Eastern Bluebird	C	PR		X	X		
* Polioptila caerulea. Blue-gray Gnatcatcher	C	PR	X	X	X		
* Regulus satrapa. Golden-crowned Kinglet	FC	WV		X			
* R. calendula. Ruby-crowned Kinglet	C	WV		X			
* Anthus spinoletta. Water Pipit	C	WV			X		
* A. Spragueii. Sprague's Pipit	AC	--			X		
* Bombycilla cedrorum. Cedar Waxwing	C	WV		X			
* Lanius ludovicianus. Loggerhead Shrike	C	PR			X		
* Sturnus vulgaris. Starling	C	PR			X		
* Vireo griseus. White-eyed Vireo	C	PR		X			
* V. flarrifrons. Yellow-throated Vireo	FC	SR		X			
* V. Solitarius. Solitary Vireo	FC	WV		X			
* V. olivaceus. Red-eyed Vireo	C	SR		X			
* Mniotilta varia. Black & White Warbler	U	WV		X			
* Protonotaria citrea. Prothonotary Warbler	FC	SR		X		X	
Limnothoypis swainsonii. Swainson's Warbler	U	SR		X		X	
* Helmitheros vermicorus. Worm-eating Warbler	U	M		X			
Vermivora chrysoptera. Golden-winged Warbler	R	M		X			
* V. pinus. Blue-winged Warbler	R	M		X	X		
V. bachmanii. Bachman's Warbler	R	SR		X		X	
V. peregrina. Tennessee Warbler	R	M		X			
* V. celata. Orange-crowned Warbler	FC	WV		X			
V. ruficopilla. Nashville Warbler	R	M			X		
* Parula americana. Northern Parula	C	SR		X			
* Dendroica petechia. Yellow Warbler	C	M		X		X	
* D. magnolia. Magnolia Warbler	U	M		X			
* D. trigrina. Cape May Warbler	FC	M		X			
* D. caerulescens. Black-throated Blue Warbler	C	M		X			
* D. coronata. Yellow-rumped Warbler	C	WV		X			
D. nigrescens. Black-throated Gray Warbler	AC	--					
D. virens. Black-throated Green Warbler	FC	SR		X			
D. cerulea. Cerulean Warbler	R	M		X			
* D. fusca. Blackburnian Warbler	R	M		X			
* D. dominica. Yellow-throated Warbler	C	PR		X			
* D. pensylvanica. Chestnut-sided Warbler	R	M		X			
D. castanea. Bay-breasted Warbler	R	M		X	X		
* D. striata. Blackpoll Warbler	C	M		X			
* D. pinus. Pine Warbler	C	PR		X			
D. kirtlandii. Kirtland's Warbler	R	M		X			
* D. discolor. Prairie Warbler	C	PR		X			
* D. palmarum. Palm Warbler	C	WV		X	X		
* Seiurus aurocapillus. Ovenbird	C	M		X			
* S. noveboracensis. Northern Waterthrush	C	M		X			

APPENDIX II-I-1
(cont'd)

	Abundance	Seasonal Occurrence	Shore	Forests	Feral	Freshwater	Estuarine
* **Seiurus motacilla.** Louisiana Waterthrush	U	M		X			
* **Oporonis formosus.** Kentucky Warbler	FC	SR		X			
O. agilis. Connecticut Warbler	R	M		X			
* **Geothlypis trichas.** Common Yellow Throat	C	PR		X		X	
* **Icteria virens.** Yellow-breasted Chat	C	PR		X	X		
* **Wilsonia citrina.** Hooded Warbler	C	SR		X			
* **W. pusilla.** Wilson's Warbler	R	M		X	X		
W. canadensis. Canada Warbler	R	M		X			
* **Setophaga ruticilla.** American Redstart	FC	M		X			
* **Passer domesticus.** House Sparrow	C	PR			X		
* **Dolichonyx oryzivorus.** Bobolink	C	M			X		
* **Sturnella magna.** Eastern Meadowlark	C	PR			X		
* **Xanthocephalus xanthocephalus.** Yellow-headed Blackbird	R	WV			X		
* **Agelaius phoeniceus.** Red-winged Blackbird	C	PR	X		X	X	X
* **Icterus spurius.** Orchard Oriole	C	SR		X			
* **I. galbula.** Northern Oriole	FC	WV		X			
* **Euphagus carolinus.** Rusty Blackbird	C	WV		X		X	
E. cyanocephalus. Brewer's Blackbird	R	WV			X		
* **Quiscalus major.** Boat-tailed Grackle	C	PR			X		X
* **Q. quiscala.** Common Grackle	C	PR		X	X	X	
* **Molsthrus ater.** Brown-headed Cowbird	C	PR			X		
* **Piranga ludoviciana.** Western Tanager	R	WV		X	X		
* **P. olivacea.** Scarlet Tanager	U	SR			X		
* **P. rubra.** Summer Tanager	C	SR			X		
* **Cardinalis cardinalis.** Cardinal	C	PR		X		X	
* **Pheucticus ludovicianus.** Rose-breasted Grosbeak	R	M		X	X		
P. melanocephalus. Black-headed Grosbeak	R	WV		X	X		
* **Guiraca caerulea.** Blue Grosbeak	FC	SR		X	X		
* **Passerina cyanea.** Indigo Bunting	C	SR		X	X		
* **P. ciris.** Painted Bunting	C	SR		X	X		
Spiza americana. Dickcissel.	R	WV			X		
* **Hesperiphona vespertina.** Evening Grosbeak	U	WV		X			
* **Carpodacus purpureus.** Purple Finch	FC	WV		X	X		
Pinicola enucleator. Pine Grosbeak	AC	WV		X			
Carduelis flammea. Common Redpoll	AC	WV			X		
* **C. pinus.** Pine Siskin	FC	WV		X			
* **C. tristis.** American Goldfinch	C	WV		X	X		
Loxia curvirostra. Red Crossbill	R	WV		X			
Pipilo chlorurus. Green-tailed Towhee	AC	--			X		
* **P. erythrophtalmus.** Rufous-sided Towhee	C	PR		X			
Calamospiza melanocorys. Lark Bunting	AC	--			X		
* **Passerculus sandwichensis.** Savannah Sparrow	C	WV			X		
* **Ammodromus savannarum.** Grasshopper Sparrow	FC	WV			X		
* **A. henslowii.** Henslow's Sparrow	U	WV			X		
Ammospiza leconteii. LeConte's Sparrow	U	WV			X		
* **A. caudacuta.** Sharp-tailed Sparrow	C	WV					X
* **A. maritima.** Seaside Sparrow	C	PR					X
* **Pooecetes gramineus.** Vesper Sparrow	C	WV			X		
* **Chondestes grammacus.** Lark Sparrow	U	M		X	X		
* **Aimophila aestivalis.** Bachman's Sparrow	FC	PR		X			

APPENDIX II-I-1
(cont'd)

	Abundance	Seasonal Occurrence	Shore	Forests	Feral	Freshwater	Estuarine
* Junco hymalis. Dark-eyed Junco	C	WV		X	X		
Spizella arborea. Tree Sparrow	R	WV			X		
* S. passerina. Chipping Sparrow	C	PR			X		
* S. pusilla. Field Sparrow	C	PR			X		
* Zonotrichia leucophrys. White-crowned Sparrow	U	WV		X	X		
* Passerella ilioca. Fox Sparrow	FC	WV		X			
Melospiza lincolnii. Lincoln's Sparrow	R	WV				X	
* M. georgiana. Swamp Sparrow	C	WV				X	
* M. melodia. Song Sparrow	C	WV		X	X	X	
Calcarius lapponicus. Lapland Longspur	AC	WV			X		
Plectrophenax nivalis. Snow Bunting	R	WV			X		

*Has been sighted on Hilton Head Island by the Audubon Society (1960 - 1974).

Adapted from: (1) Forsythe, D.M. 1978. Birds. In: R.G. Zingmark (ed.) 1978. An Annotated Checklist of the Biota of the Coastal Zone of South Carolina. University of South Carolina Press: Columbia.

(2) Shanholtzer, G.M. 1974. Checklist of Birds Occurring in the Coastal Region Georgia: Species, Abundance, and Habitat. In: A.S. Johnson, et.al. 1974. An Ecolofical Survey of the Coastal Region of Georgia.

APPENDIX II-I-2

MAMMALS OF THE SOUTH CAROLINA COAST

	Verified Occurrences	
	Hilton Head	Beaufort Co., S.C.
Order Marsupialia (Pouched Mammals)		
Didelphis virginiana. Oppossum. Abundant. Beaches, woodlands.	X	X
Order Insectivora (Insect-eaters)		
Blarina brevicauda. Short-tailed Shrew Common. Woodlands, thickets.		
Cryptotis parva. Least Shrew Common. Fields, shrub thickets.		
Sorex longirostris. Southeastern Shrew Rare. Moist woods, swamps, marshes.		
Condylura cristata. Star-nosed Mole Rare. Damp woods, meadows.		X
Scalopus aquaticus. Eastern Mole Abundant. Various habitats.		X
Order Chiroptera (Bats)		
Eptesicus fuscus. Big Brown Bat Uncommon. Buildings.		
Lasionycteris noctivagans. Silver-haired Bat Uncommon. Trees, buildings.		
Lasiurus borealis. Red Bat Common. Trees.		X
L. cinereus. Hoary Bat Uncommon. Trees.		
L. intermedius. Northern Yellow Bat Rare. Trees with spanish moss.		
L. seminolus. Seminole Bat Fairly common. Trees with spanish moss.		X
Myotis austroriparius. Southeastern Myotis Uncommon.		
M. lucifugus. Little Brown Myotis Accidental		X
Nycticeius humeralis. Evening Bat Common. Buildings, trees.		X
Pipistrellus subflavus. Eastern Pipistrelle. Common. Trees, buildings.		
Plecotus rafinesquii. Rafinesque's Big-eared Bat Uncommon. Buildings, trees.		X
Tadarida brasiliensis. Brazilian Free-tailed Bat Common. Trees, buildings.	X	X
Order Edentata (Sloths and Armadillos)		
Dasypus novemcinctus. Armadillo Uncertain abundance. Woodlands, brushy areas.		X

APPENDIX II-I-2
(cont'd)

	Occurrences	
	Hilton Head	Beaufort Co., S.C.
Order Lagomorpha (Rabbits)		
Sylvilagus floridanus. Eastern Cottontail. Abundant. Fields, brush, thickets, dunes.		X
S. palustris. Marsh Rabbit Abundant. Fresh and salt water marshes, swamps.	X	X
Order Rodentia (Gnawing Mammals)		
Glaucomys volans. Southern Flying Squirrel Common. Woodlands.	X	X
Sciurus carolinensis. Gray Squirrel Abundant. Woodlands, particularly hardwoods.	X	X
Sciurus niger. Fox Squirrel Uncommon. Hardwood and pine forests.		X
Microtus pennsylvanicus. Meadow Vole Rare. Low moist area - thickets, fields.		
M. pinetorum. Pine Vole Uncommon. Various habitats.		X
Neotoma floridana. Eastern Wood Rat Common. Beaches, dunes, nature forests.		X
Ochrotomys palustris. Golden Mouse Uncommon. Woodlands, thickets.		X
Oryzomys palustris. Marsh Rice Rat Abundant. Fresh and salt water marshes, near streams.		X
Peromyscus gossypinus. Cotton Mouse Abundant. Lowland and swamp forests, brushy areas.	X	X
Reithrodontomys humulis. Eastern Harvest Mouse Uncommon. Fields, thickets, marshes, waste areas.		
Sigmodon hispidus. Cotton Rat Abundant. Beaches, dunes, fields, shrub thickets.	X	X
Mus musculus. House Mouse. Abundant. Houses, barns, fields.		X
Rattus norvegicus. Norway Rat Abundant. Buildings, dumps, salt marshes.	X	X
Rattus rattus. Black Rat Common. Buildings.		
Order Cetacea (Whales, Dolphins, and Porpoises) (Various species of whales and dolphins have been spotted in coastal waters and are occassionally stranded on beaches. Most species are rarely seen and only of migratory presence.)		
Tursiops truncatus. Bottle-nosed Dolphin Common, only "resident" cetacean. Estuaries, harbors, tidal channels, offshore.	X	X
Order Carnivora		
Urocyon cinereoargenteus. Gray Fox Common. Woodlands, swamps.		X
Vulpes fulva. Red Fox Uncommon (Introduced). Woodlands and open areas.		X
Euarctos americanus. Black Bear Rare. Large mainland river swamps. (Probably originally present on coastal islands.)		X

APPENDIX II-I-2
(cont'd)

	Occurrences	
	Hilton Head	Beaufort Co., S.C.
Procyon lotor. Raccoon	X	X
Common. Woodlands, salt marsh edges, beaches.		
Lutra canadensis. River Otter	X	X
Common. Rivers, tidal creeks, salt marshes, ponds.		
Mephitis mephitis. Striped Skunk		
Uncommon. Farmland, waste areas.		
Mustela frenata. Long-tailed Weasel		
Uncommon. Woodlands, open fields.		
Mustela vison. Mink	X	X
Common. Salt marshes, tidal creeks.		
Felis concolor. Cougar		
Uncertain (Formerly present, but now extirpated or extremely rare).		
Lynx rufus. Bobcat	X	X
Fairly Common. Swamps, thickets, brush.		
Order Pinnipedia (Sea Lions and Seals)		
Phoca vitulina. Harbor Seal	X	X
Uncommon. Coastal waters, harbors and bays.		
Order Sirenia (Manatee)		
Trichechus manatus. Manatee		X
Uncommon. Coastal waters - sheltered marine bays sluggish rivers.		
Order Artiodactyla (Even-toed Hoofed Animals)		
Odocoileus virginianus. White-tailed Deer	X	X
Common. Beach dunes, woodlands, swamps, fields, marshes.		
Sus scrofa. Feral Swine	X	X
Locally abundant. (Introduced) Woodlands, swamps, dunes.		

References

(1) Burt, W.H. and R.P. Grossenheider. 1976, Field Guide to the Mammals. Houghton Mifflew Co.: Boston.

(2) Hopkins, S. 1979. Personal Communication (District Biologist, S.C. Wildlife & Marine Resources Dept., Beaufort, S.C.)

(3) Jenkins, J.H. 1972. The Mammals of Hilton Head Plantation with suggestions for their preservation. (Manuscript prepared for Sea Pines Co., Hilton Head Island, S.C.)

(4) Neuhouser, H. and W. Baker. 1974. Annotated List of Mammals of the Coastal Islands of Georgia, in Johnson, et.al. 1974. An ecological survey of the coastal region of Georgia. National Park Service. Scientific Mono. Series, No. 3. U.S.G.P.O.#2405-00563.

(5) Sanders, A.E. 1978. Mammals in R.G. Zingmark (ed.) 1978. An annotated checklist of the biota of the coastal zone of South Carolina. University S.C. Press: Columbia.

APPENDIX II-I-3

AMPHIBIANS AND REPTILES OF THE SOUTH CAROLINA COAST

Explanation of Abbreviations
Status (in order of decreasing abundance):

A - Abundant
C - Common
FC - Fairly Common
U - Uncommon
O - Occassional
R - Rare
L - Locally (preceding other terms)

		Sitings or Records	
	Status*	Hilton Head	Beaufort Co., S.C.
CLASS AMPHIBIA			
Order Caudata (Salamanders)			
Pseudobranchus striatus. Broad-striped Dwarf Siren	R		X
Siren intermedia. Eastern Lesser Siren	C		X
S. lacertina. Greater Siren	U-LC		
Nectarus punctatus. Dwarf Waterdog	U		
Notophtalmus viridescens. Newt	C		
Amphiuma means. Two-toed Amphiuma	C		X
Ambystoma cingulatum. Flatwoods Salamander	U		X
A. mabeei. Mabee's Salamander	C		X
A. maculatum. Spotted Salamander	C		X
A. opacum. Marbled Salamander	A		X
A. talpoideum. Mole Salamander	A		X
A. tigrinum. Eastern Tiger Salamander	R		
Desmognathus auriculatus. Southern Dusky Salamander	A		
Eurycea bislineata. Southern Two-lined Salamander	C		
E. longicauda. Three-lined Salamander	U		
E. quadridigitata. Dwarf Salamander	A		X
Plethodon glutinosus. Slimy Salamander	A		X
Pseudotriton montanus. Mud Salamander	U-R		X
Stereochilus marginatus. Many-lined Salamander	U		
Order Anura (Frogs and Toads)			
Scaphiopus holbrooki. Eastern Spadefoot Toad	A	X	X
Bufo quercicus. Oak Toad	A	X	X
B. terrestris. Southern Toad			
Acris crepitans. Northern Cricket Frog	R		
Acris gryllus. Southern Cricket Frog	A		X
Hyla avivoca. Bird-voiced Treefrog	C		
H. chrysocelis. Cope's Gray Treefrog	A		
H. cinerea. Green Treefrog	A	X	X
H. crucifer. Spring Peeper	A		X
H. Lemoralis. Pine Woods Treefrog	A		
H. gratiosa. Barking Treefrog	C		X

APPENDIX II-I-3
(cont'd)

		Records	
	Status*	Hilton Head	Beaufort Co., S.C.
Hyla squirella. Squirrel Treefrog	A	X	X
Limnaoedus ocularis. Little Grass Frog	A		X
Pseudacris brimleyi. Brimley's Chorus Frog	A		
P. nigrita. Southern Chorus Frog	C		X
P. ornata. Ornate Chorus Frog	C		X
P. triseriata. Upland Chorus Frog	LA		
Rana areolata. Carolina Gopher Frog	U		
R. catesbeiana. Bullfrog	C		X
R. clamitans. Bronze Frog	C		X
R. grylio. Pig Frog	C		X
R. heckscheri. River Frog	C		
R. palustris. Pickerel Frog	R		
R. utricularia. Southern Leopard Frog	A	X	X
R. virgatipes. Carpenter Frog	A		
Gastrophryne carolinensis. Eastern Narrow-mouth Toad	A	X	X
CLASS REPTILIA			
Order Testudines (Turtles)			
Chelydra serpentina. Snapping Turtle	C		X
Kinosternon subrubrum. Eastern Mud Turtle	C		X
Sternotherus odoratus. Stinkpot	C		
Chrysemys concinna. River Cooter	U		
Chrysemys floridana. Florida Cooter	FC		
C. scripta. Yellow-bellied Turtle	A		X
Clemmys guttata. Spotted Turtle	R-O		
Deirochelys reticularia. Eastern Chicken Turtle	C		X
Malaclemys terrapin. Diamondback Terrapin	C		X
Terrapene carolina. Eastern Box Turtle	C		
Gopherus polyphemus. Gopher Tortoise	R		
Trionyx ferox. Florida Softshell	N-C		X
T. spiniferus. Gulf Coast Spiny Softshell	U		
Caretta caretta. Atlantic Loggerhead	C	X	X
Chelonia mydas. Atlantic Green Turtle	R		
Eretmochelys imbricata. Atlantic Hawksbill	R		
Lepidochelys kempi. Atlantic Ridley	R		
Dermochelys coriacea. Atlantic Leatherback	R		
Order Crocodilia			
Alligator mississippiensis. Alligator	O-A	X	X
Order Squamata (Lizards and Snakes)			
Anolis carolinensis. Green Anole	LA		
Sceloporus undulatus. Fence Lizard	LC		
Cnemidophorus sexlineatus. Six-lined Racerunner	LA		A
Eumeces fasciatus. Five-lined Skink	LC		
E. inexpectatus. Southeastern Five-lined Skink	LC		X
E. laticeps. Broad-headed Skink	LC		
Ophisaurus attenuatus. Eastern Slender Glass Lizard	U		
O. compressus. Island Glass Lizard	R		
O. ventralis. Eastern Glass Lizard	O		
Carphophis amoenus. Eastern Worm Snake	R-U		
Cemophora coccinea. Northern Scarlet Snake	U		X

APPENDIX II-I-3
(cont'd)

	Status*	Hilton Head	Beaufort
Coluber constrictor. Southern Black Racer	A		X
Diadophis punctatus. Southern Ringneck Snake	U-C		
*Drymarchon corais. Eastern Indigo Snake	--		
Elaphe guttata. Corn Snake	FC		
E. obsoleta. Yellow Rat Snake	C		X
Farancia abacura. Eastern Mud Snake	U		X
F. erytrogramma. Rainbow Snake	U		X
Heterodon platyrhinos. Eastern Hognose Snake	C		
H. simus. Southern Hognose Snake	U		
Lampropeltis getulus. Eastern Kingsnake	C		
L. triangulum. Scarlet Kingsnake	U		
Masticophis flagellum. Eastern Coachwhip	U		
Natrix cyclopion. Florida Green Water Snake	R		
N. erythrogaster. Red-bellied Water Snake	LC		
N. fasciata. Banded Water Snake	A		X
N. rigida. Glossy Water Snake	R		
N. taxispilota. Brown Water Snake	LA		
Opheodrys aestivus. Rough Green Snake	U-C		
Pituophis melanoleucus. Pine Snake	W-FC		
Rhadinaea flavilata. Pine Woods Snake	LR-U		
Seminatrix pygaea. Carolina Swamp Snake	R		
Storeria dekaryi. Brown Snake	LC-R		
S. occipitomaculata. Red-bellied Snake	LR-C		
Tantilla coronata. Southeastern Crowned Snake	U		
Thomnophis sauritus. Ribbon Snake	LU-A		
T. sirtalis. Eastern Garter Snake	U-LC		X
Virginia striatula. Rough Earth Snake	R-LC		
V. caleriae. Eastern Earth Snake	R		
Micrurus falvius. Eastern Coral Snake	R		
Agkistrodon contortrix. Southern Copperhead	C	X	X
A. piscivorus. Cottonmouth	A	X	X
Sistrurus miliarius. Pygmy Rattlesnake	U		X
Crotalus horridus. Canebrake Rattlesnake	FC		
C. adamanteus. Eastern Diamondback Rattlesnake	U-LC	X	X

*Although reported from S.C. in earlier times, the indigo snake has not been recorded within the state in recent years; no museum specimens are available from S.C.

(1) Table adapted from: Harrison, J.R. and J.W. Gibbons, IN: Zingmark, R.G. 1978. An Annotated Checklist of the Biota of the Coastal Zone of South Carolina. Univ. of S.C. Press: Columbia.

(2) Some sitings from: Hopkins, S. 1979. Personal communication. (District Biologist, S.C. Wildlife & Marine Resources Dept., Beaufort, S.C.)

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV -
ATLANTA

HILTON HEAD ISLAND
ENVIRONMENTAL
IMPACT STATEMENT

TECHNICAL REFERENCE DOCUMENT A
ENVIRONMENTAL INVENTORY
TASK REPORT

VOLUME 2
MAN-MADE ENVIRONMENT

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
CLAUDE TERRY AND ASSOCIATES, INC.

V2

SECTION III

DESCRIPTION OF THE MAN-MADE ENVIRONMENT

S-III

CHAPTER III-A

POPULATION

Population changes and distributions have a significant impact on water quality management decisions since they serve as the basis for determining wastewater flows and loads, facility design capacity, and facility location. Every year, two federal agencies, formerly known as the Department of Commerce Office of Business Economics and the Department of Agriculture Economic Research Service (OBERS), release population projections for every state. Thereafter, each state disaggregates its OBERS statewide total to the county level, and then local agencies disaggregate county figures to sub-district levels. Table III-A-1 shows the state disaggregations for Beaufort County developed by the South Carolina Office of Research and Statistics (ORS) in 1979.

The Director of the ORS, the Planning Director of the Lowcountry Council of Governments, and the Executive Director of the Beaufort Joint Planning Commission feel that these figures are quite conservative and are not in line with historical trends in population growth. Because EPA generally bases its construction grants allocations on OBERS population projections, residents of Beaufort County in general and Hilton Head in particular are concerned about the amount of local funding necesary to finance wastewater management systems if the actual population

TABLE III-A-1

BEAUFORT COUNTY OBERS POPULATION PROJECTIONS

Year	Population
1980	65,000
1985	70,000
1990	77,000
1995	82,000
2000	86,371

Source: South Carolina Office of Research and Statistics, 1979.

turns out to be significantly higher than OBERS projections.

A second aspect of the local concern over population levels in the year 2000 is that of the carrying capacity of the island in terms of natural and man-made systems. Many of the developers and employed persons on the island support greater intensity of development and population densities than do many of the other permanent residents, particularly retirees.

The island's population is composed of a number of groups, some of whom can be quantified more easily than others. Data are available about the following components: permanent residents, overnight resort visitors, day visitors, property owners who are seasonal residents and do not rent their units, and employees of island businesses who themselves live off the island. Historically, estimates of the size of these population components have varied widely, but more precise documentation has been developed during the late 1970's.

The following sections of this chapter discuss information available regarding the five major population components listed above.

PERMANENT RESIDENTS

The 1970 Census of permanent residents reported 2,546 persons on Hilton Head Island. This figure was disputed locally and later revised to 4,200. A Special Census conducted by the U. S. Bureau of Census in 1975 determined that the island's permanent resident population was then 6,511. This growth can be attributed largely to the rapid development of the plantations and other resort areas.

The Special Census was confined to gathering information about population by age, race, and sex. No data on family incomes, employment, residential patterns, and other socio-economic indicators were generated. This information will not be available until the analyses of the 1980 Census are published.

Table III-A-2 summarizes the findings of the 1975 Special Census by census enumeration districts which are shown in Plate III-A-1. Hilton Head Island accounted for 12.3 percent of total county population whereas it represented an estimated 8.2 percent in 1970.

Table III-A-2 shows a pattern of distinct residential segregation. The southern end of the island and Atlantic Ocean frontage are inhabited almost exclusively by whites. Blacks represent a majority only in districts 1 and 3. As Hilton Head Plantation continues to develop, white population figures will increase sharply in district 1. The 1980 Census is expected to show significantly larger population gains among whites than among blacks on an island-wide basis due to the projected growth of the resort/plantation developments.

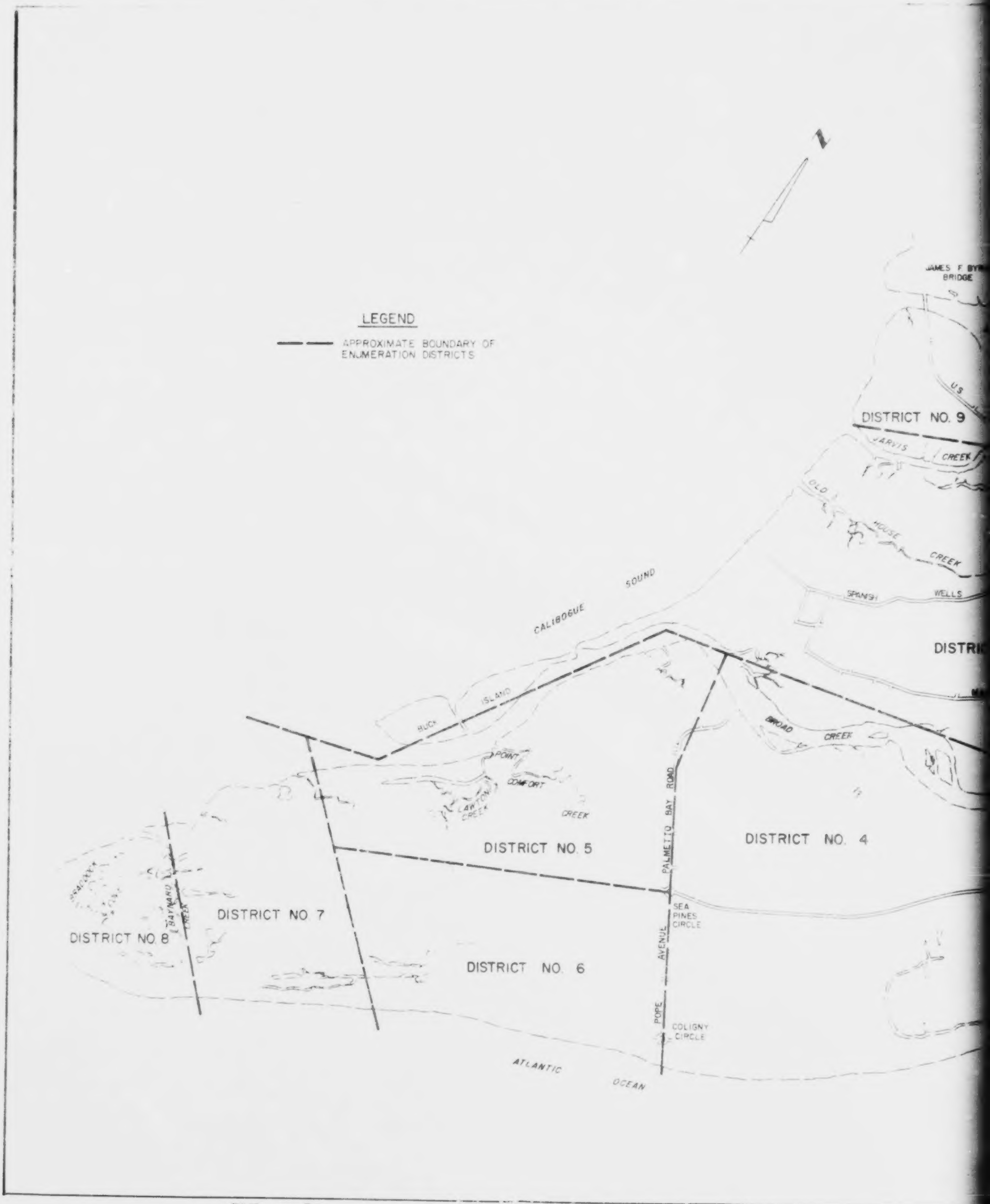
TABLE III-A-2

POPULATION CHARACTERISTICS, BY CENSUS ENUMERATION DISTRICTS

Enumeration District	Total	District Population					Median Age
		Sex		Race			
		Male	Female	White	Black	Other	
1	607	293	314	135	468	4	22.1
2	669	327	342	551	118	0	30.4
3	1,021	525	496	498	523	0	24.5
4	1,339	693	646	1,206	126	7	27.6
5	644	311	333	633	11	0	30.2
6	1,315	672	643	1,275	36	4	30.6
7	636	311	325	634	1	1	56.2
8	250	110	140	250	0	0	58.5
9	30	18	12	30	0	0	--(1)
Totals:							
Island (1975)	6,511	3260	3251	5,212	1,283	16	29.6
Beaufort County (1970)	51,136			33,864	16,848	424	20.8

Source: Special Census, Hilton Head Island, conducted by the U. S. Census Bureau; current as of April 7, 1975.

(1) Median figure is not calculated by the Census Bureau for any category in which the base is less than 50. In this case, the total population (or "base") in the Enumeration District is only 30.


N
LEGEND
APPROXIMATE BOUNDARY OF ENUMERATION DISTRICTS
JAMES F BY
BRIDGE
US
DISTRICT NO. 9
JARVIS
CREEK
OLD
HOUSE
CREEK
SPANISH
WELLS
CALIBOGUE
SOUND
DISTRI
BUCK
ISLAND
BROAD
CREEK
POINT
COMFORT
LAWTON
CREEK
CREEK
PALMETTO BAY ROAD
DISTRICT NO. 4
DISTRICT NO. 5
SEA
PINES
CIRCLE
BAYNARD
CREEK
DISTRICT NO. 7
DISTRICT NO. 8
DISTRICT NO. 6
POPE
AVENUE
COLIGNY
CIRCLE
ATLANTIC
OCEAN

III-47.3a

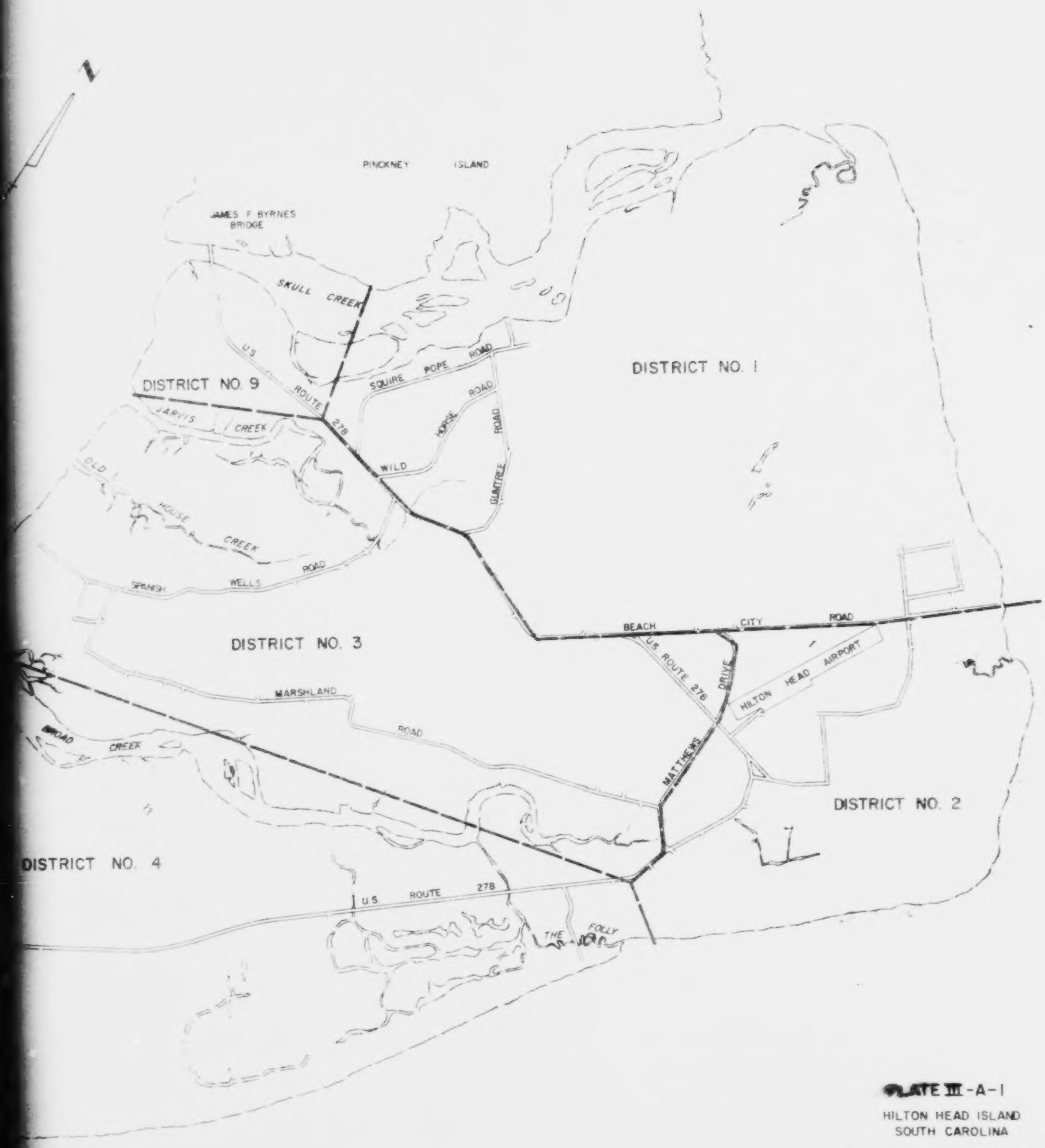

N
PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
US ROUTE 278
SQUIRE POPE ROAD
DISTRICT NO. 9
DISTRICT NO. 1
JARVIS CREEK
WILD HORSE ROAD
GUMTREE ROAD
OLD HOUSE CREEK
SPANISH WELLS ROAD
BEACH CITY ROAD
DISTRICT NO. 3
US ROUTE 278
MATTHEWS DRIVE
HILTON HEAD AIRPORT
MARSHLAND ROAD
BROAD CREEK
DISTRICT NO. 2
DISTRICT NO. 4
US ROUTE 278
THE FOLLY

PLATE III-A-1

HILTON HEAD ISLAND
SOUTH CAROLINA

CENSUS ENUMERATION DISTRICTS

0

SCALE IN FEET

US ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

Table III-A-2 also shows island population in each district broken down by median age. Districts 7 and 8 include those areas of Sea Pines Plantation developed in large-lot single family homes which have been purchased by large numbers of affluent retirees. Smaller clusters of retirees are found elsewhere on the island. Younger middle to upper income working couples and families are largely found in the plantation developments, and middle to lower income workers are located in predominantly multi-family housing outside the plantations. The Joint Planning Commission expects that the lowest income groups will continue to be concentrated in districts 1 and 3. The availability of housing for lower income groups is presently a problem due to high land and construction costs, and the situation is not expected to ease in the future.

During the 1970's five groups have made population projections for the island's permanent residents. The Hilton Head Island Chamber of Commerce released studies in 1973 and 1979. The Beaufort County 201 Wastewater Facilities Plan made several population estimates in 1975 and selected one, "The Countywide Average 1970-1973", as the most probable trend line. The Beaufort County Joint Planning Commission developed a different set of figures in 1977. The South Carolina Office of Research and Statistics has disaggregated the 1979 OBERS projection for Beaufort County which differs from all of the above. Table III-A-3 displays the five future population projections for the island.

The 1980 Final Census figures for the island show 11,344 permanent residents. This count tends to confirm the projection methodologies of

TABLE III-A-3

HILTON HEAD RESIDENT POPULATIONS

	Chamber 1973	201 County-wide Avg. 1975	JPC 1977	Chamber 1979	OBERS/ ORS 1979
1970	4,200	3,026	2,546		
1971	5,400				
1972	5,900				
1973	6,400				
1974	7,500				
1975	8,800		6,511*	6,511*	6,500
1976	10,300			7,200	
1977	12,100		7,500	7,900	
1978	14,200			8,700	
1979	16,700			9,500	
1980	19,600		10,478	10,500	9,117
1981				11,200	
1982				12,000	
1983				12,900	
1984				13,800	
1985			14,443	14,700	12,200
1990	25,480		18,409		15,571
1995	29,302	17,492	22,375		18,944
2000			26,341		21,961

*Special Census base.

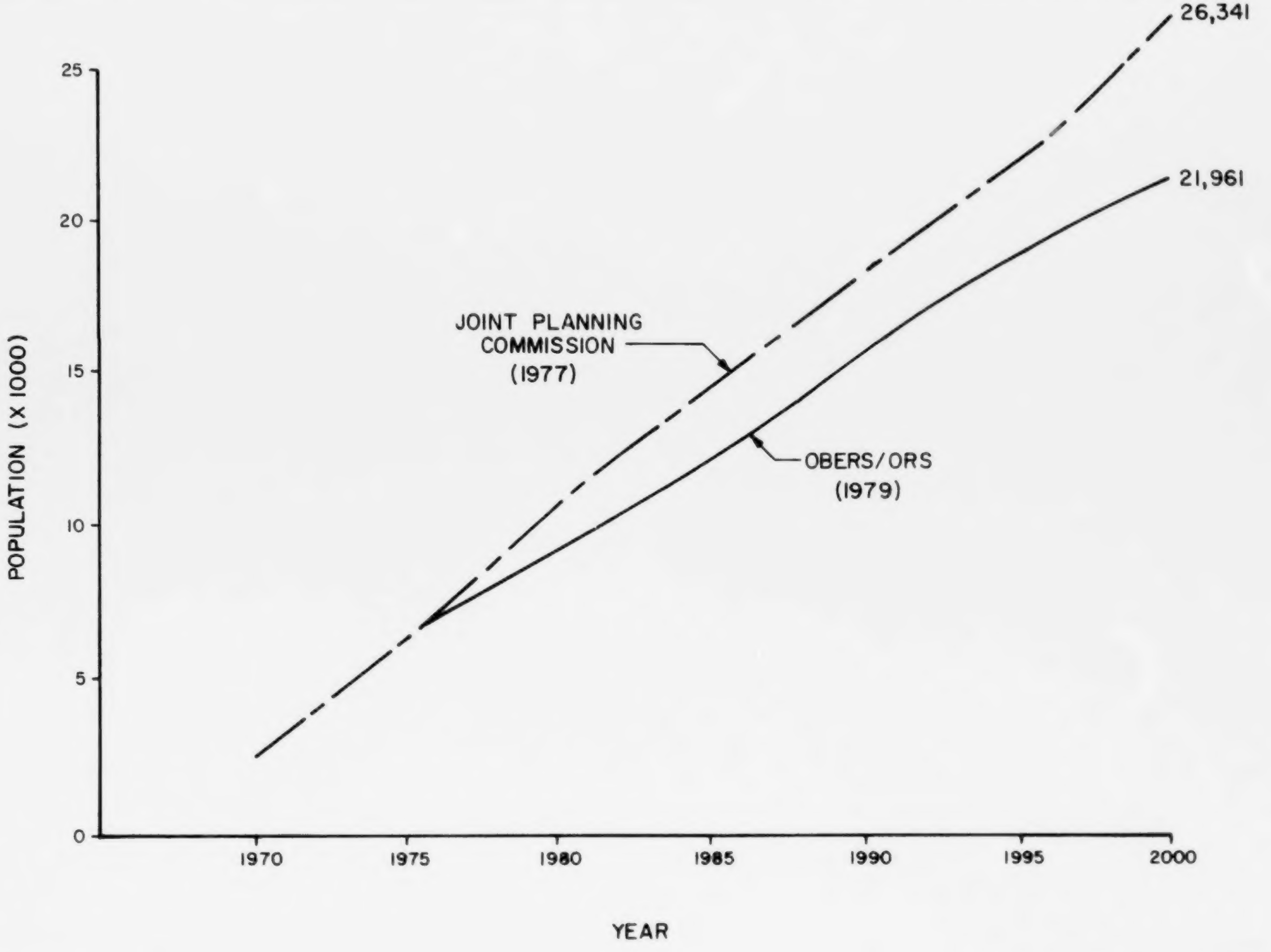
the JPC (1977) and Chamber of Commerce (1979).

It is generally agreed throughout the study area that the 1973 Chamber of Commerce figures, developed during the boom years of the early 1970's, are overly optimistic and may be dismissed from current considerations. It is possible to argue that the 201 figure for 1995 is too low because it is based on the countywide average, and Hilton Head Island's population is growing considerably faster than that of the rest of the county. The remaining three studies are basically in agreement until 1985 when local figures and OBERS projections begin to diverge significantly. By the year 2000, the JPC's estimates are approximately 20 percent higher than OBERS figures, as shown in Figure III-A-1. This difference is significant since it affects the location, sizing, and phasing of wastewater management systems.

OVERNIGHT RESORT VISITORS

The Chamber of Commerce has served as the central clearinghouse in maintaining statistics about part-time residents and resort visitors. Recent statistics are contained in the Chamber's Visitor Survey, 1976-1977. The period studied covered the year March 1, 1976 through February 28, 1977. A second report is the Chamber's Advanced Bookings Survey, 1978-1979.

The method used in collecting the data for the Visitor Survey was to ask the cooperating companies involved in renting rooms, villas, homes, and apartments to off-island visitors to provide the number of guest/owner nights for each night of the week. In addition, the number of persons in each unit and the number of days of stay were obtained. The figures also included the number of off-island housing owners renting through agents, who used their own villas or homes, the number of guests, and the length of



HILTON HEAD ISLAND
POPULATION PROJECTION
PERMANENT RESIDENTS

FIGURE III -A - I

stay in days. The figures, however, do not include any record of visits to the island of any off-island owners and their guests not renting through agents, or owners renting property directly to overnight visitors.

Table III-A-4 shows average daily visitors to the island who stayed overnight. As the table indicates, summer is the height of the tourist season when peak wastewater flows must be accommodated.

The Chamber of Commerce, in cooperation with the Hilton Head Island Innkeepers Association, developed a weekly report of the advance resort guest-owner bookings for the island during March 1, 1978-February 28, 1979 fiscal year. The companies that provided booking figures were the major hotels, inns, motels and the leading villa/home rental agents--Holiday Inn, Hyatt on Hilton Head Island, Islander Inn, Palmetto Dunes Resort, Sea Crest Motel and Sea Pines Plantation.

During each week of the 1979 fiscal year, each of the cooperating companies confidentially provided the Chamber the number of guest-owner nights booked for the following week. These guest-owner figures represent the number of nights booked multiplied by the number of guest-owners per unit.

The advance booking figures can be altered by last minute cancellations, "no shows", and last minute "walk ins". When several of the larger companies compared their advance booking figures with their actual occupancy figures, they found that the actual figures were slightly larger

TABLE III-A-4

AVERAGE DAILY OVERNIGHT GUESTS

Month	Total	Hotel - Motel	Villa - Homes
March '76	3,872	1,238	2,634
April	5,654	1,699	3,955
May	3,858	1,413	2,445
June	5,713	1,754	3,959
July	7,251	2,083	5,168
August	7,783	2,192	5,591
September	3,494	1,473	2,021
October	3,517	1,259	2,258
November	2,657	925	1,732
December	1,523	339	1,184
January '77	1,333	404	929
February	2,148	683	1,466
Annual Daily Average	4,067	1,289	2,778

Seasonal Recap

Spring	4,461
Summer	6,916
Fall	3,223
Winter	1,668
Annual Avg.	4,067

Source: Hilton Head Island Chamber of Commerce, 1977.

than the advance bookings figures. Therefore, this report may be considered a conservative estimate of actual activities (a compilation of actual activities was not made).

The Visitor Survey (FY 1977) report solicited information from all resort operators and rental agents on the island. Not all of these groups were approached for participation in the Advanced Bookings survey. The Chamber found that a small number of companies accounted for 75 percent of advanced booking volume, and only these companies participated in the FY 1979 survey. Therefore, Table III-A-5 shows average visitors per day per month as follows: in 1977 as reported by the Visitor Survey; in 1979 as actually reported by the companies polled by the Advanced Bookings survey; and in 1979 expressed as the extrapolation to 100 percent based on the Advanced Bookings survey having represented 75 percent of estimated activity.

Figure III-A-2 shows visitor information in graphic form. Over time, the profile is approximately the same, and the peak deviates significantly from the average.

The average daily net gain of 109 visitors shown in Table III-A-5 and Figure III-A-2, may be considered lower than actual activities since the figures in the Advanced Booking Survey are known to be lower than actual activities.

Donald Hobart, Research Director of the Chamber of Commerce, reports that the energy crisis has had an effect on tourism during the

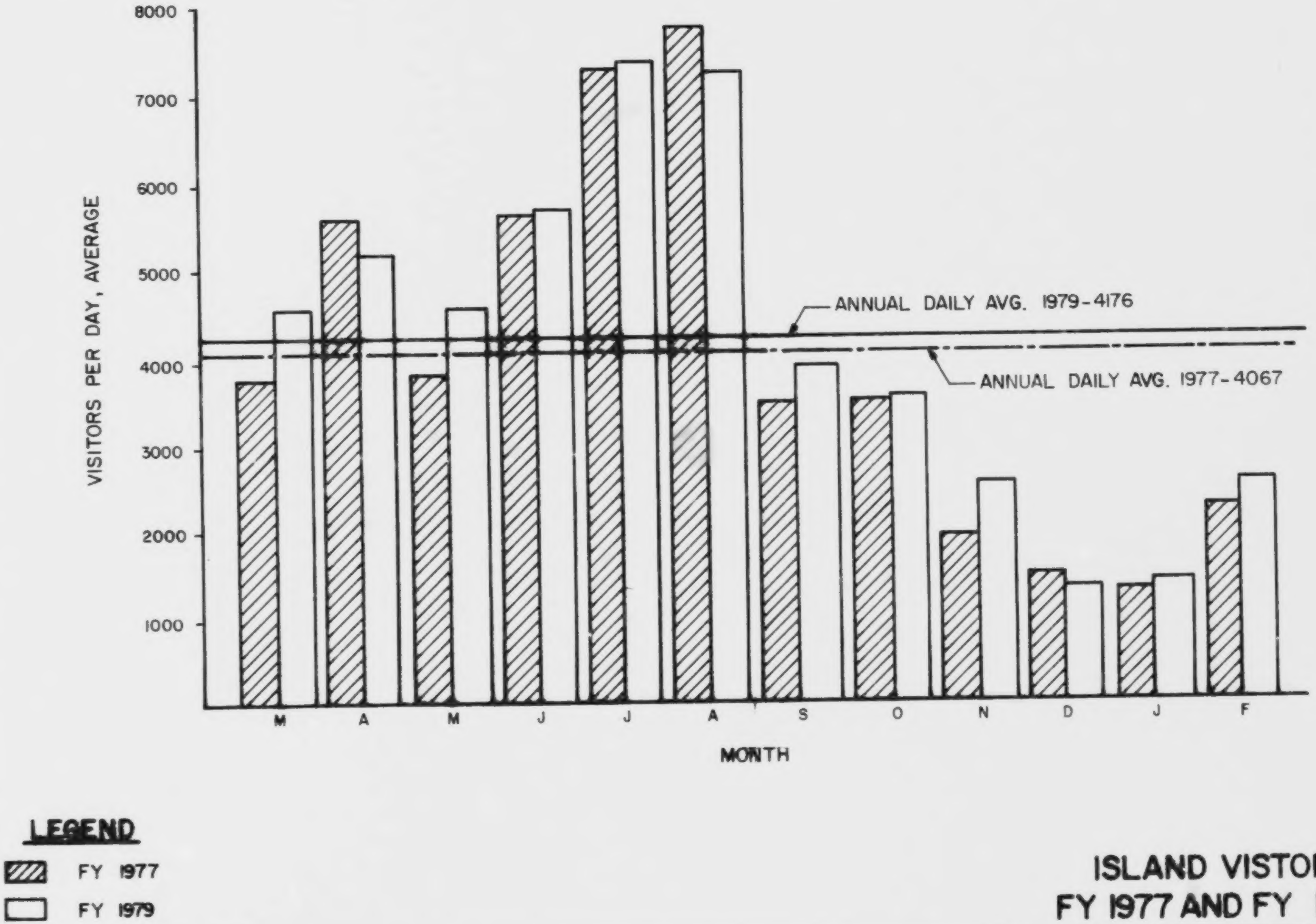
TABLE III-A-5

COMPARISON OF AVERAGE VISITORS PER DAY, 1977 AND 1979

	Visitor Survey Report FY 1977 (100%)	Advanced Bookings Report FY 1979 (75%)	Extrapolation of Advanced Bookings FY 1979 (100%)	Difference*
March	3,872	3,517	4,689	+817
April	5,654	3,874	5,165	-489
May	3,858	3,436	4,581	+723
June	5,713	4,329	5,772	+ 59
July	7,251	5,466	7,288	+ 37
August	7,783	5,397	7,196	-587
September	3,494	2,935	3,913	-419
October	3,517	2,671	3,561	+ 44
November	2,657	1,908	2,544	-113
December	1,523	1,042	1,389	-134
January	1,333	1,091	1,455	+122
February	2,149	1,918	2,557	-408
Annual Daily Average	4,067		4,176	+109

*Col. 3 minus Col. 1 = Difference

Source: Hilton Head Island Chamber of Commerce, 1979.



ISLAND VISTORS,
FY 1977 AND FY 1979

FIGURE III -A-2

summer of 1979. Smaller resort owners were more greatly affected than was Sea Pines Plantation, which accounts for approximately 50 percent of resort volume business. Sea Pines found that during the 13-week June-to-September summer season, 1979 visitation equalled or exceeded 1978 visitation except during four weeks.

At a May 22, 1980 meeting of the Citizen Review Committee, a committee member suggested that the overnight visitor figure was too low. Subsequent research showed that the Advanced Bookings Report statistics were more conservative than previously anticipated. Walk-in business and underreporting of numbers of persons in each rental party are thought to account for additional overnight visitors not originally discovered.

An alternative approach to estimating peak overnight visitors is based on taking the known number of rental units and multiplying by both a persons per rental unit factor and an occupancy rate for the peak season. The results of this methodology when used in the Sea Pines PSD agree closely with current wastewater flows metered at the treatment plant and it is assumed that the correlation is valid for the other PSD's.

The EIS project team worked with the Chamber of Commerce Marketing Research Department to make new estimates for the overnight visitor population component. The 1979-80 inventory of villa and house rental units was divided into two groups: Group I containing 1,577 units with a 70 percent peak season occupancy rate and Group II containing 1,030 units with a 40 percent peak season occupancy rate. The majority of villas contain two bedrooms, although there are some three-bedroom units and a few one-bedroom units. Two-bedroom rental units generally contain four visitors and often more. For purpose of these estimates, however, 4.0 persons per unit was chosen.

Hotels, motels, and inns were also divided into two groups: Group I containing 850 rooms with a 96 percent peak season occupancy rate and Group II containing 274 rooms with a 70 percent peak season occupancy rate. Group I rooms are estimated to contain 2.0 persons per room, and Group II rooms are estimated to contain 1.7 persons per room. Table III-A-6 shows the factors used to compute the overnight visitor population component.

Statistics maintained for calendar year 1979 show that the annual average of overnight visitors represents 65 percent of the peak. This percentage is larger than that of previous years and reflects the effectiveness of resort operators' efforts to increase visitation during the spring and fall seasons and thus extend the summer seasonal peak. Therefore, the average number of overnight visitors in 1980 can reasonably be estimated at 5,230.

OFF-ISLAND EMPLOYMENT

The Chamber of Commerce has published a series of four biannual reports analyzing employment on the island. The reports contain actual 1972, 1974, 1976, and 1978 figures, not estimates. Over half of the island employees reside on Hilton Head. The remaining 43 percent, or 3,257 off-island employees (1978), are primarily employed by the resort-restaurant

TABLE III-A-6

OVERNIGHT VISITORS, 1980

Group	No. of Units	Occupancy Rate	Persons Per Unit	Peak Population
Gr I - Villas	1,577	70	4.0	4,416
Gr II - Villas	1,030	40	4.0	1,648
Gr I - Hotels	854	96	2.0	1,640
Gr II - Hotels	274	70	1.7	326
	3,735			8,030

Source: Claude Terry & Associates, Inc., 1980.

and construction businesses. These businesses have traditionally attracted people from the Savannah area, Beaufort, and Jasper County and continue to be a major employer for the surrounding counties. Table III-A-7 shows geographic origin of employees by major business group.

Table III-A-8 presents a comparison of employment figures published in the four reports. Substantial gains have been made in both the number of businesses and number of employees. Employees who live on-island have increased nearly twice as fast as off-island employees since 1972, as is illustrated in Figure III-A-3.

SEASONAL RESIDENTS WHO NEVER RENT THEIR UNITS

Many persons who own property on the island maintain their permanent residences elsewhere. A number of seasonal residents list their houses and villas with rental agencies, and the persons who rent these units are accounted for in the Overnight Resort Visitors section of this chapter. However, those seasonal residents who do not rent their units publicly constitute the fourth population component in this study.

A method was developed to determine the size of this group. It is estimated that 9,544 units have been constructed by June, 1980. Permanent residents occupy approximately 3,519 units, and 2,607 units are listed with rental agencies. Therefore, 3,418 units are owned by seasonal residents who never rent their units. Statistics developed by the Marketing Research Department of the Chamber of Commerce show that during the peak season, 16.7 percent of these seasonal residents are occupying their units, for a total

TABLE III-A-7

NUMBER AND PERCENT OF EMPLOYEES LIVING ON AND OFF ISLAND, 1978

Type of Business	Number on Isl.	Percent of Total on Isl.	Number Off Isl.	Percent of Total Off Isl.
Construction	573	13.4%	816	25.1%
Fin., Ins. & Real Estate	298	7.0%	36	1.1%
Resort & Restaurant	1575	36.8%	1427	43.8%
Retail & Wholesale	721	16.8%	362	11.1%
Schools & Government	165	3.8%	37	1.1%
Services	747	17.4%	410	12.6%
Professional	(308)	(7.2%)	(68)	(2.1%)
Other	(439)	(10.2%)	(342)	(10.5%)
Trans., Comm. & Utilities	204	4.8%	169	5.2%
TOTAL:	4283	100.0%	3257	100.0%
	(57%)		(43%)	

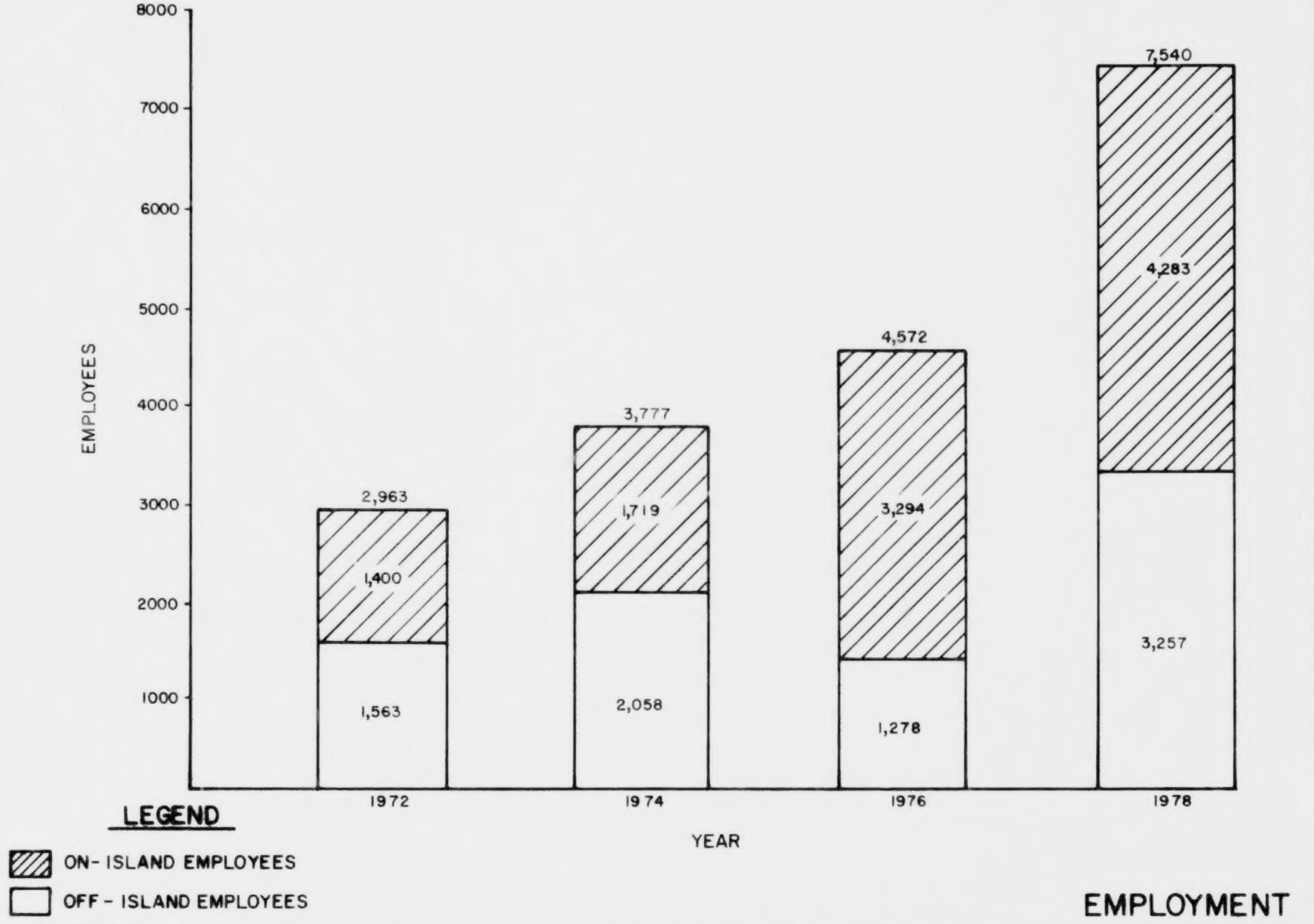
Source: Hilton Head Island Chamber of Commerce. Hilton Head Island Business Survey, 1978. August 1979.

TABLE III-A-8

COMPARISON OF 1972, 1974, 1976 AND 1978 SURVEYS
PERCENT INCREASE AND NET GAINS

	1972	1974	(Net Gains)	1976	(Net Gains)	1978	(Net Gains)	% Increase 1972-1978
Business	120	205	(+85)	438	(+233)	598	(+160)	398%
Employees	2963	3777	(+814)	4572	(+795)	7540	(+2968)	155%
Male	1891	2452	(+561)	2649	(+197)	4580	(+1931)	142%
Female	1072	1325	(+253)	1923	(+598)	2960	(+1037)	176%
Island	1400	1719	(+319)	3294	(+1575)	4283	(+989)	206%
Off-Island	1563	2058	(+495)	1278	(-708)	3257	(+1979)	108%

Source: Hilton Head Island Chamber of Commerce. Hilton Head Island Business Survey, 1978. August 1979.



EMPLOYMENT

FIGURE III - A-3

of 571 units occupied. Assuming 4.0 persons per unit during July/August, this population component totals 2,284 persons.

DAY VISITORS

Visitors who come to the island for the day and do not require overnight lodging are considered a separate population component. This group composed of the following kinds of persons:

1. Employees of off-island businesses: subcontractors on construction jobs, service and repairmen, deliverymen, etc.
2. Persons who come to spend the day at the beach or to shop.
3. Guests of island residents who come for a day of golf, tennis, etc.

The Market Research Department of the Chamber of Commerce estimates this component to number approximately 750 persons per day during the peak summer season.

AGGREGATION OF POPULATION COMPONENTS

Table III-A-9 summarizes information about the five population components in 1980 and shows both average and peak season figures.

ORS is the only agency to have attempted to generate population projections for the three largest components of Hilton Head Island's population (residents, overnight visitors, and off-island employees). In 1977, day visitors and seasonal residents who do not rent their units had not been quantified. Their methodology consisted of developing a series of ratios

TABLE III-A-9

1980 DAILY POPULATION ESTIMATE

	Average	Peak
Permanent Residents	10,478	10,478
Overnight Visitors	5,230	8,030
Off-Island Employees	3,257	3,257
Seasonal Residents	2,284	2,284
Day Visitors	500	750
	21,749	24,799

Source: Hilton Head Island Chamber of Commerce, 1980.

between the 1975 resident population, 1976 visitor population, and 1976 employment population. The source of the latter two sets of figures were the Hilton Head Island Chamber of Commerce's Visitor Survey, 1976 and Business Survey, 1976.

Typically, ratios are developed between a sub-district and the next larger entity, such as the island and Beaufort County. However, population growth on Hilton Head Island has historically varied in rate from that of the County, and therefore, a different set of ratios had to be devised. Thus, the ORS decided to develop a set of ratios internal to the island (Personal communication, Dr. Andy Laurent, Director ORS; November 1, 1979) as follows:

1. Average overnight visitors represent 57 percent of resident population.
2. Peak month overnight visitors represent 191 percent of average overnight visitors.
3. Resort and restaurant employment represents 55 percent of average overnight visitors.
4. All other employment represents 33 percent of resident population.
5. Off-island employees represent 28 percent of total employees.

By stepping through the above formula and using the OBERS projection of residential population for the year 1995 (shown in Table III-A-3), a total population figure can be calculated. Table III-A-10 demonstrates these computations. No allowance was made for seasonal residents or day visitors.

Table III-A-10 shows that the peak population is 29.6 percent greater than average daily population. This differential is extremely important in wastewater management systems since facilities must be able to handle peak flows.

TABLE III-A-10

POPULATION PROJECTION FOR 1995 USING OBERS BASE AND 1976 VISITOR AND EMPLOYMENT DATA

Population Component	Avg. Pop.	Peak Pop.
Residential Base (Table III-A-3)	18,944	18,944
Overnight Visitors		
(.57) (18,944)	10,798	
(1.91) (10,798)		20,624
Off-Island Employment		
(.28) [(.55) (10,798) + (.33) (18,944)]	3,413	3,413
Total Population	33,155	42,981

Source: South Carolina Office of Research Statistics, 1977

In June 1980, a revised population projection was undertaken including updated overnight visitor figures shown in Table III-A-6 plus the new population components: day visitors and seasonal residents who never rent their units. Employment data from the Business Survey, 1972 - 1978 was used. Employing the ORS methodology and modifications by Claude Terry & Associates for the two additional population components, the following figures are generated:

1. Average daily overnight visitors represent 50 percent of JPC resident population (5,230/10,478 = .50).
2. Peak month overnight visitors represent 154 percent of average daily overnight visitors (8,030/5,230 = 1.54).
3. (Resort and restaurant employees have increased at the average rate of 351 persons annually during the past six years. Given 3,002 persons in this employment sector in 1978, it can reasonably be estimated that the number is approximately 3,704 in 1980). Thus, resort and restaurant employees represent 71 percent of average daily overnight visitors (3,704/5,230 = .71).
4. (All other employment exclusive of resort and restaurant employment has risen at the average rate of 412 persons annually for the past 6 years. Given 4,538 employees in "other" sectors in 1978, 5,362 persons in 1980 is a reasonable estimate.) Thus, all other employment represents 51 percent of resident population (5,362/10,478 = .51).
5. Total employment in 1980 is estimated at 9,066. The off-island employee proportion of 43 percent in 1978 (See Table III-A-7) is still considered reasonable for 1980.
6. Seasonal residents represent 22 percent of permanent residents (2,284/10,478 = .22).
7. Average day visitors represent 2.4 percent of the sum of all four other average population components (500/21,249 = .024).
8. Peak day visitors represent 3.1 percent of the sum of all four other peak population components (750/24,041 = .031).

Table III-A-11 shows the computations for the year 2000 population projection. An analysis of Table III-A-11 shows the percent of total population that each component represents. These factors are shown in Table III-A-12.

The distribution factors were used to produce Table III-A-13 which shows population projections for the island in five-year increments. Both OBERS and JPC figures are shown. Population peak figures as projected by the JPC is consistently higher than OBERS peak figures, ranging between 20.0 percent and 29.3 percent. The information in Table III-A-13 is displayed graphically in Figure III-A-4.

EVALUATION OF PROJECTION AND METHODOLOGIES

A great deal of statistical uncertainty surrounds all population projections. Much can happen in a small geographic area to upset even the best projections. Because Hilton Head Island's future population and economic growth are heavily dependent on tourism and immigration or retirement to the Sunbelt, any national constraints to growth in these areas can have a major impact on the island. For example, Hilton Head Island's economy was very sensitive to the 1974-1976 recession and the gasoline shortages of the energy crisis. A recurrence of either event can be expected to have a similar impact.

In coming years, developers' policies will greatly influence the validity of these projections. The degree to which developers pursue resort/convention business versus constructing dwelling units for permanent

TABLE III-A-11

POPULATION PROJECTION FOR 2000 USING JPC BASE AND 1980 DATA FOR OTHER COMPONENTS

Population Component	Avg. Pop.	Peak Pop.
Residential Base (given)	26,341	26,341
Overnight Visitors		
(.50) (26,341)	13,171	
(1.54) (13,171)		20,283
Off-Island Employment		
(.43) [(.71) (13,171) + (.51) (26,341)]	9,798	9,798
Seasonal Residents		
(.22) (26,341)	5,795	5,795
Day Visitors		
(.024) (55,105)	1,323	
(.031) (62,217)		1,928
	56,428	64,145

Source: Claude Terry & Associates, Inc., 1980

TABLE III-A-12

POPULATION COMPONENT DISTRIBUTION FACTORS

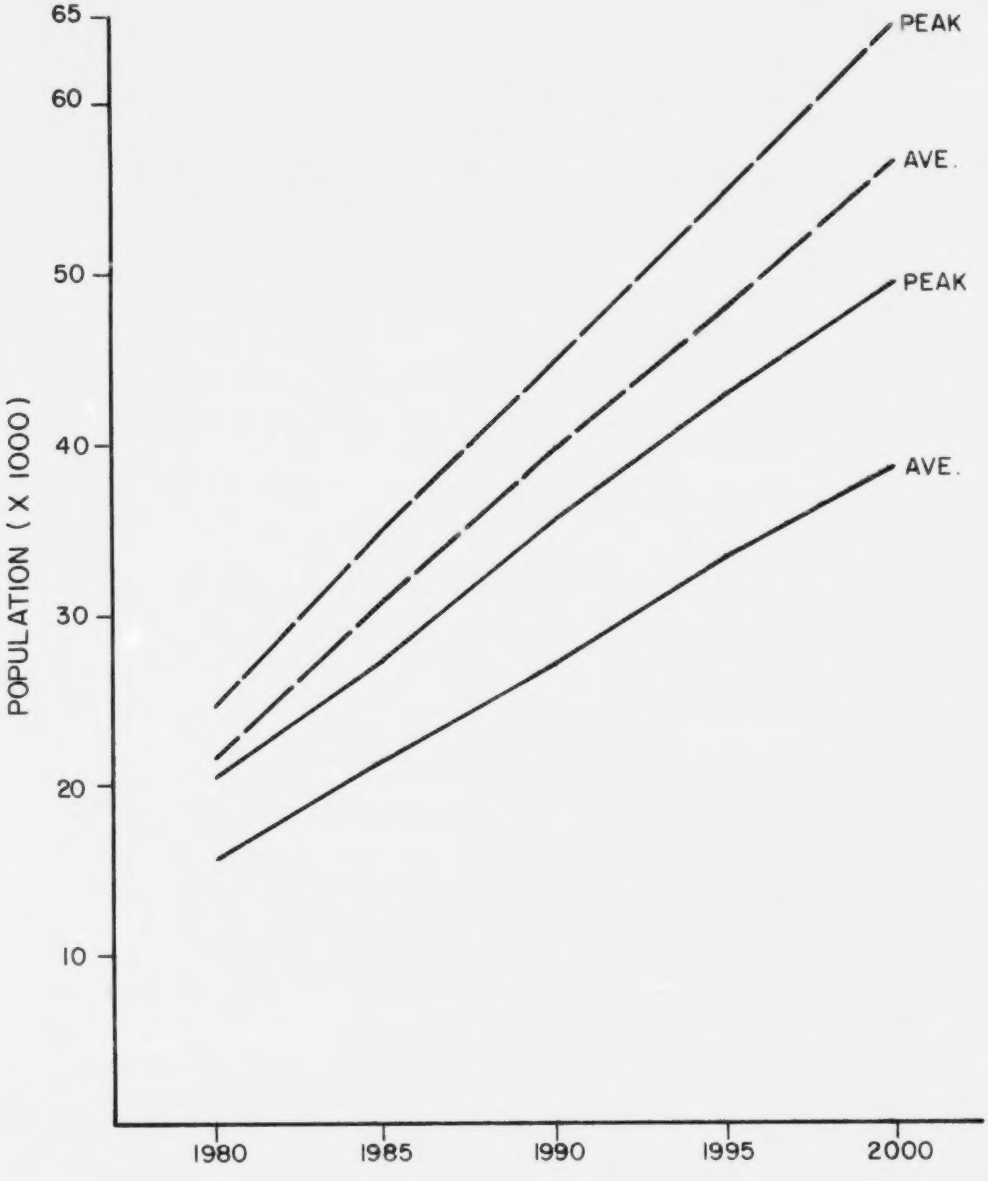
Component	Average	Peak (%)
Residents	46.7	41.1
Overnight Visitors	23.3	31.6
Off-Island	17.4	15.3
Seasonal Residents	10.3	9.0
Day Visitors	2.3	3.0
	100.0	100.0

Source: Claude Terry & Associates, Inc., 1980.

TABLE III-A-13

ISLAND-WIDE AVERAGE AND PEAK POPULATION IN FIVE-YEAR INCREMENTS

	1980		1985		1990		1995		2000	
	Avg	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak
OBERS Perm Residents	9,117	9,117	12,200	12,200	15,571	15,571	18,944	18,944	21,961	21,961
Overnight Visitors	5,196	9,924	6,954	13,282	8,875	16,951	10,798	20,624	12,518	23,909
Off-Island Employees	1,641	1,641	2,196	2,196	2,803	2,803	3,413	3,413	3,953	3,953
Total	15,954	20,682	21,350	27,678	27,249	35,325	33,155	42,981	38,432	49,823
JPC Perm Residents	10,478	10,478	14,443	14,443	18,409	18,409	22,375	22,375	26,341	26,341
Overnight Visitors	5,230	8,030	7,206	11,118	9,185	14,171	11,164	17,223	13,142	20,277
Off-Island Employees	3,257	3,257	5,381	5,381	6,859	6,859	8,336	8,336	9,814	9,814
Seasonal Residents	2,284	2,284	3,186	3,186	4,060	4,060	4,935	4,935	6,110	6,110
Day Visitors	500	750	711	1,055	907	1,345	1,102	1,636	1,298	1,925
Total	21,749	24,799	30,927	35,183	39,420	44,844	47,912	54,505	56,705	64,467
JPC higher than OBERS by:	20.0%		27.1%		27.0%		26.8%		29.4%	



AVERAGE AND PEAK POPULATIONS
IN FIVE-YEAR INCREMENTS

FIGURE

III-A-27a

residents will greatly affect future population levels. In addition, unless the construction of housing for low and moderate income persons is increased significantly, the numbers of off-island employees will rise at an increasing rate. However, at an unknown date beyond the design period, as the island approaches full build-out and employment in the construction sector turns down, the number of off-island employees may decrease since many are currently employed in the construction sector.

CHAPTER III-B

EXISTING LAND USE

Existing and future land use are important factors in water quality management planning; the pattern and density of development have major implications for the type and location of wastewater treatment and disposal facilities to be recommended by the EIS. Until recently, much of the information about existing land use has been dispersed among the files of developers, the PSD's and the Beaufort Joint Planning Commission (JPC). However, the JPC currently has underway a major land use planning effort, and much of the data about land use necessary for this report has recently been assembled by JPC staff and is now available to the public.

Until the 1950's, Hilton Head Island was largely undeveloped. With the formation of the Hilton Head Company, the Sea Pines Company, and construction of Byrnes Bridge in 1956, development began according to the resort/plantation concept. Plantations are best described as large scale planned unit developments which combine residential and open space/recreation land uses and occasionally include shopping facilities and restaurants.

In the intervening 23 years, approximately 30 percent of the island's 42 square miles have been developed. This statistic is illustrated in Figure III-B-1. The south end of the island is more intensively developed than the north end. Figure III-B-2 shows existing land use on Hilton Head Island. Table III-B-1 shows the land uses occupying the island's 27,954 acres and the percent utilization of each land use category. A further breakdown of these figures is shown in Table III-B-2 which presents acreage statistics for major geographic areas of the island. These statistics are shown graphically in Figure III-B-3.

The following sections of this report describe the characteristics of each land use type.

RESIDENTIAL

Residential land uses occupy one-third of all developed acreage on the island and 10.1 percent of the total land area. Two-thirds of residential acreage is used for single-family housing and the remainder for multi-family units and mobile homes.

In recent years, developers have been concentrating their efforts on multi-family units in response to market conditions and an increasing emphasis on attracting vacationers as well as permanent residents. Table III-B-3 shows numbers of dwelling units broken down in plantation and non-plantation categories. This table is illustrated in Figure III-B-4.

Table III-B-3 shows that the majority of single-family homes are found within the plantations. Sea Pines Plantation accounts for the largest concentration of residential development on the island. Table III-B-4 compares

TABLE III-B-1

SUMMARY OF EXISTING LAND USE BY ACRES AND PERCENT USE

Land Use	Acres	Percent
Residential	2,814	10.1
Single-family	1,883	6.7
Multi-family	615	2.2
Mobile Home	316	1.2
Public Subsidized Housing	0	0
Commercial	360	1.3
Industrial/Utility	31	0.1
Open Space/Recreation	3,716	13.3
Institutional/Public Facility	160	0.6
Cemetery	25	0.1
Transportation		
Streets, alleys, roads, utility rights of way	1,090	3.9
Forest/Agriculture	214	0.8
Total Developed Area	8,410	30.2
Undeveloped Area	19,544	70.0
Vacant	14,561	52.2
Marsh	4,308	15.4
Water	674	2.4
TOTAL:	27,954	100.0

Source: Beaufort County Joint Planning Commission, 1979.

TABLE III-B-2

EXISTING LAND USE BY MAJOR GEOGRAPHIC AREAS

Land Use	Plantation	N & S Forest Beach	Non-Plantation	Total
Residential				
Single-Family	922	256	705	1883
Multi-Family	301	145	169	615
Mobile Home	0	0	316	316
Public Subsidized Housing	0	0	0	0
Commercial	60	65	235	360
Industrial Utility	24	0	7	31
Open Space/Recreation	3705	4	8	3716
Institutional/Public Facility	17	32	111	160
Cemetery	0	0	25	25
Transportation Streets,roads,alleys, utility right of way	603	136	351	1090
Forest/Agriculture	0	0	214	214
TOTAL DEVELOPMENT AREA	5632	642	2137	8410

Source: Beaufort Joint Planning Commission, 1979

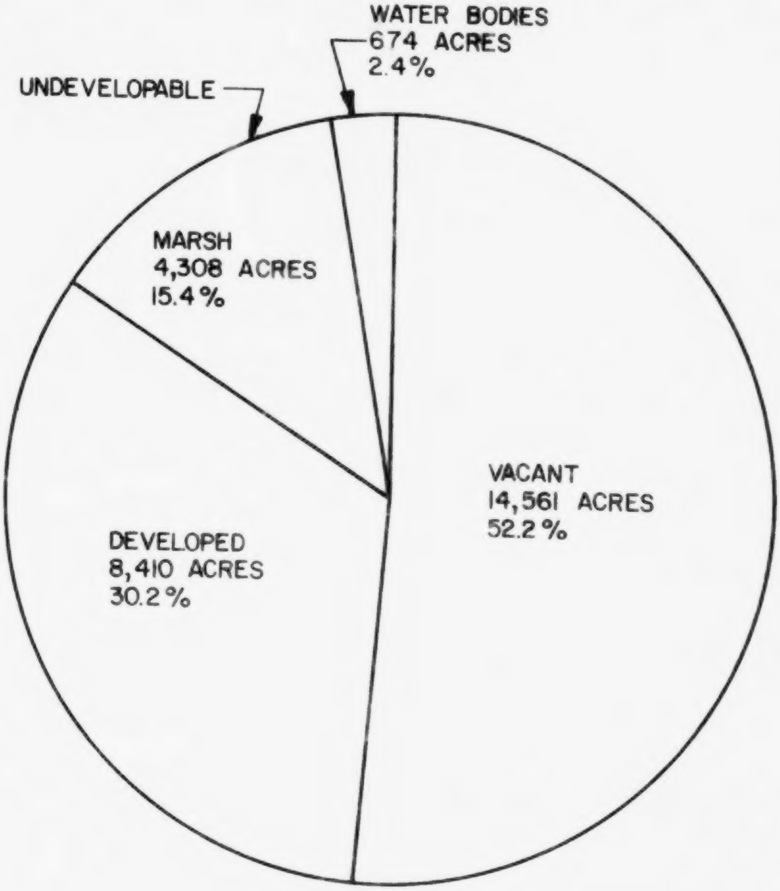
TABLE III-B-3

TYPES OF DWELLING UNITS

Type	Plantation		Non-Plantation		Total
Single-Family	2270	(70.8%)	935	(29.2%)	3205
Multi-Family*	2436	(43.7%)	3140	(56.3%)	5576
Mobile Home	0	(00.0%)	251	(100.0%)	251
	4706	(52.1%)	4326	(47.9%)	9032

*Hotels, Motels, Villas, Apartments, Duplexes, Quadruplexes, etc.

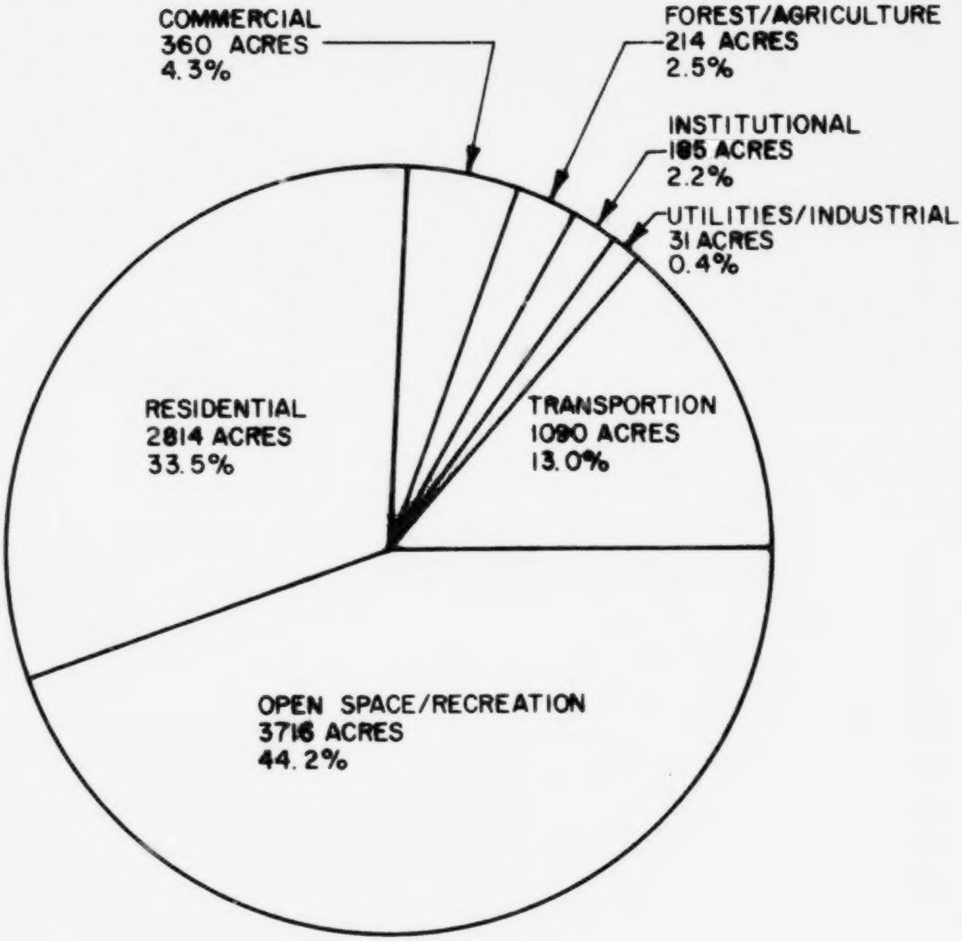
Source: Beaufort, Joint Planning Commission; August 21, 1979.



DEVELOPED vs,
UNDEVELOPED LAND, 1979

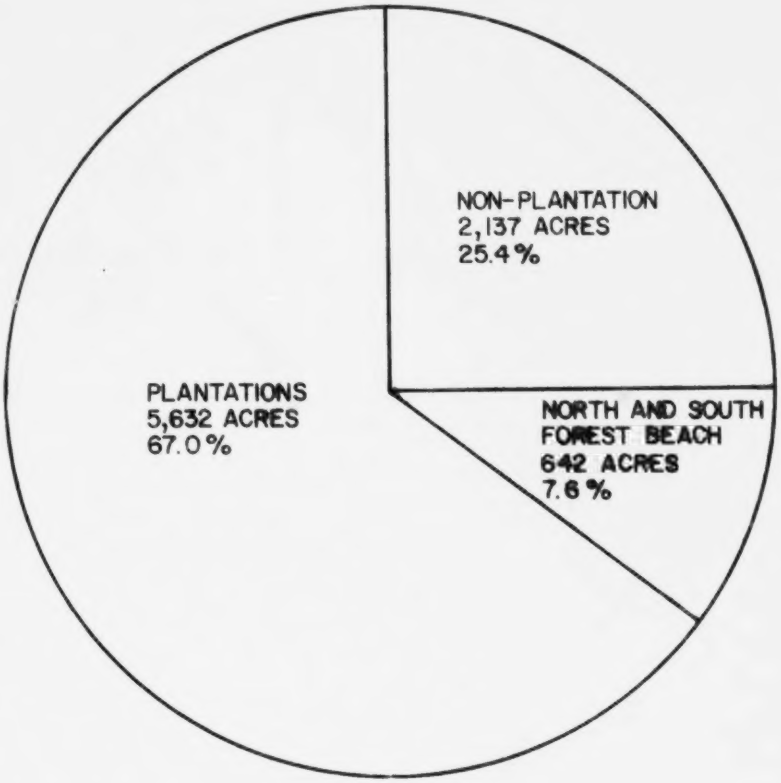
III-B-3a

FIGURE



DEVELOPED LAND
IN 1979: 8410 ACRES

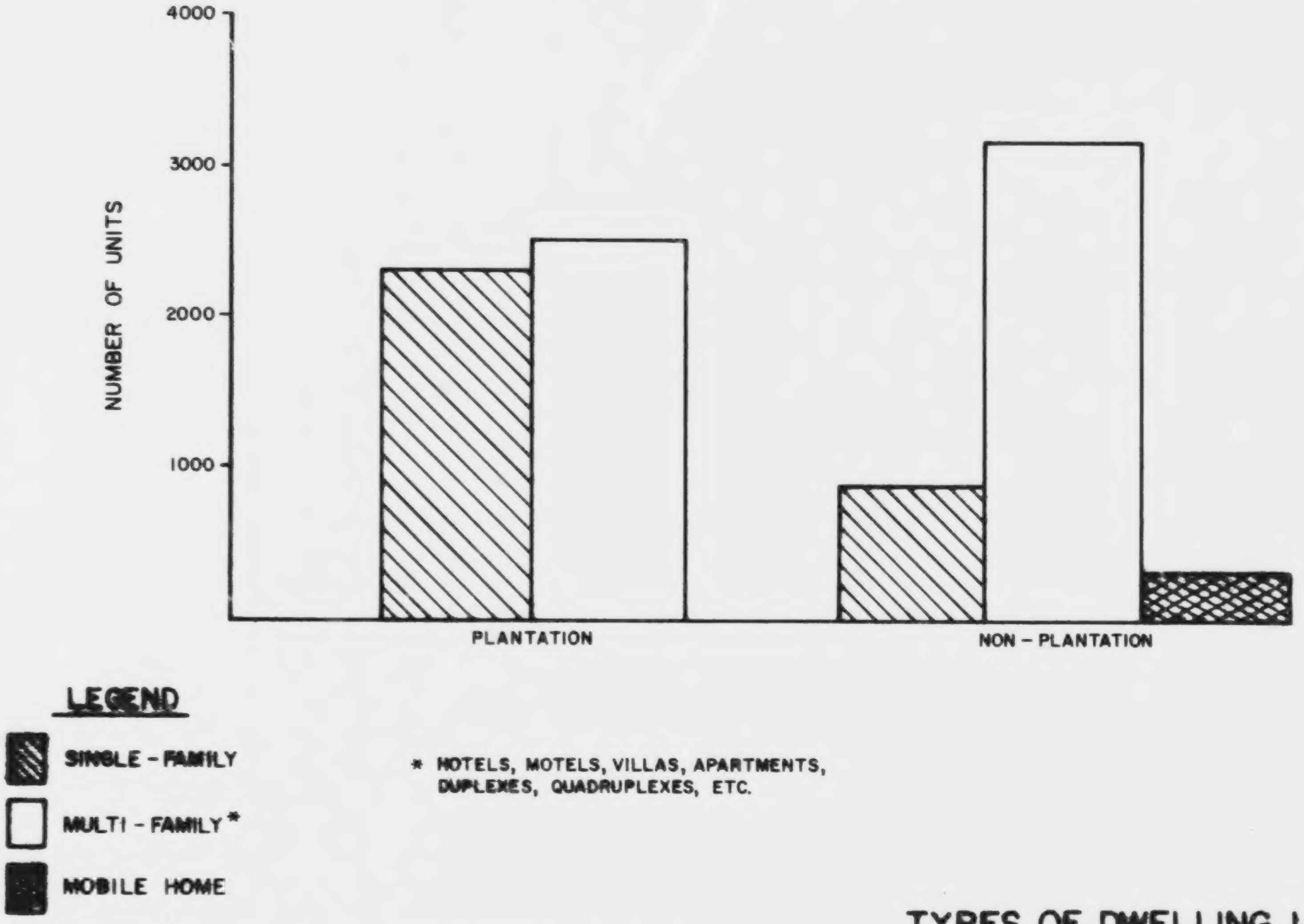
FIGURE III-B-2



CONCENTRATIONS OF
DEVELOPMENT, 197

II-B-3c.

FIGUR



* HOTELS, MOTELS, VILLAS, APARTMENTS, DUPLEXES, QUADRUPLEXES, ETC.

TYPES OF DWELLING UNITS, 1979

FIGURE III - B - 4

the Sea Pines build out to that of all plantations combined and shows that over two-thirds of plantation units are found at Sea Pines.

Other concentrations of single-family homes are located in North and South Forest Beach. Smaller clusters of single-family homes are found in the Black communities of Baygall, Squire Pope, Jonesville, Marshland, Spanish Wells, Gardner, Otter Hole, and Singleton Beach.

Multi-family units are more evenly divided between plantation and non-plantation areas. Outside the plantations, the largest concentrations of multi-family units is found in the North and South Forest Beach areas, followed by an area on the northern end of the island bounded by Palmetto Dunes Resort - Port Royal Plantation - Hilton Head Plantation - Gardner Matthews Plantation. The first area contains 2087 units on approximately 145 acres. The second area contains 500 units on approximately 56 acres. Excluding hotels, motels, and the Sea Cabins, multi-family units range in density from 3.5 to 18.68 units per acre. An unofficial height limit of five stories prevails on the island.

All mobile homes are located outside the plantations. One mobile home park is located at the north end of the island on Gumtree Road, and a second is located on Marshland Road near Broad Creek. Otherwise, mobile homes are scattered singly or in small clusters in the rural areas of the northern half of the island.

Table III-B-5 correlates dwelling unit types with structural condition.

TABLE III-B-4

COMPARISON OF PLANTATION BUILD OUT

Type	Sea Pines	Total	Percent
SF	1845	2270	81.3
MF	1365	2436	56.0
	3210	4706	68.2

Source: Beaufort Joint Planning Commission and Sea Pines Plantation Company; August, 1979.

TABLE III-B-5

STRUCTURAL CONDITION OF DWELLING UNIT TYPES

Type	Location	Condition 1	Condition 2	Condition 3	Total
Single-Family	Plantation	2,270	0	0	2,270
	Non-Plantation	854	66	15	935
					3,205
Multi-Family	Plantation	2,436	0	0	2,436
	Non-Plantation	3,140	0	0	3,140
					5,576
Mobile Home	Plantation	0	0	0	0
	Non-Plantation	251	0	0	251
					251

Condition 1 - No defects in structure; needs only regular maintenance.
Condition 2 - Needs more than regular maintenance.
Condition 3 - Does not provide safe shelter; endangers life and health

Source: Beaufort Joint Planning Commission, August 21, 1979.

Only 81 units out of a total housing stock of 9,032 units show any defects. These statistics are not surprising due to the recent nature of development on the island. None of the defective units are found within the plantations.

COMMERCIAL

Commercial land uses occupy 360 acres or approximately 1.3 percent of the island and is increasing rapidly in response to population growth. The Chamber of Commerce's Hilton Head Island Business Survey, 1978 shows that the number of businesses on the island has increased nearly 400 percent since 1972, from 120 to 598 enterprises. Demand for commercial land is expected to remain strong.

Historically, the major concentration of commercial activities was the Sea Pines - Pope Avenue - Coligny Circle Corridor since the south end of the island has developed more rapidly than the north end. In recent years, the commercial district around Matthews Drive has expanded and Pineland Mall has been constructed. Strip commercial development has begun along Highway 278 and has become an issue of local concern.

Small neighborhood shopping centers have been built within the plantations or adjacent to them. The largest commercial district within a plantation is Harbour Town, whose market extends beyond Sea Pines.

INDUSTRY/UTILITY

This land use occupies 31 acres on the island and is almost entirely used by utilities. Hilton Head has no heavy industry, and none is expected. The very limited amount of light industry is confined to enterprises supporting the construction sector. An industrial park has been planned for the Matthews Drive area, but currently only commercial enterprises and utility activities are located there. The utility companies serving the island are Hargray Telephone Company, Palmetto Electric Cooperative, and Pargas Liquid Propane Supply Company. Water and sewer services are furnished by the PSD's or Hilton Head Plantation Utilities Corporation which serves the Hilton Head Plantation.

OPEN SPACE/RECREATION

Approximately 3,716 acres, or 13.3 percent of the island, is set aside for open space and recreation uses. All but 12 acres are devoted to private uses and located within plantation or resort boundaries. The only major exception is the 60-acre Newhall Nature Preserve, which is owned by a private non-profit organization (Audubon Society) and open to the public without fee. Much of the private open space is protected by deed restricted covenants.

INSTITUTIONAL/PUBLIC AND SEMI-PUBLIC

This category contains 1,275 acres and includes public buildings, schools, churches, libraries, cemeteries, roads, transportation facilities, hospitals, and utility rights-of-way. Approximately half of this acreage is contained within the plantations and the other half on non-plantation lands.

FOREST/AGRICULTURE

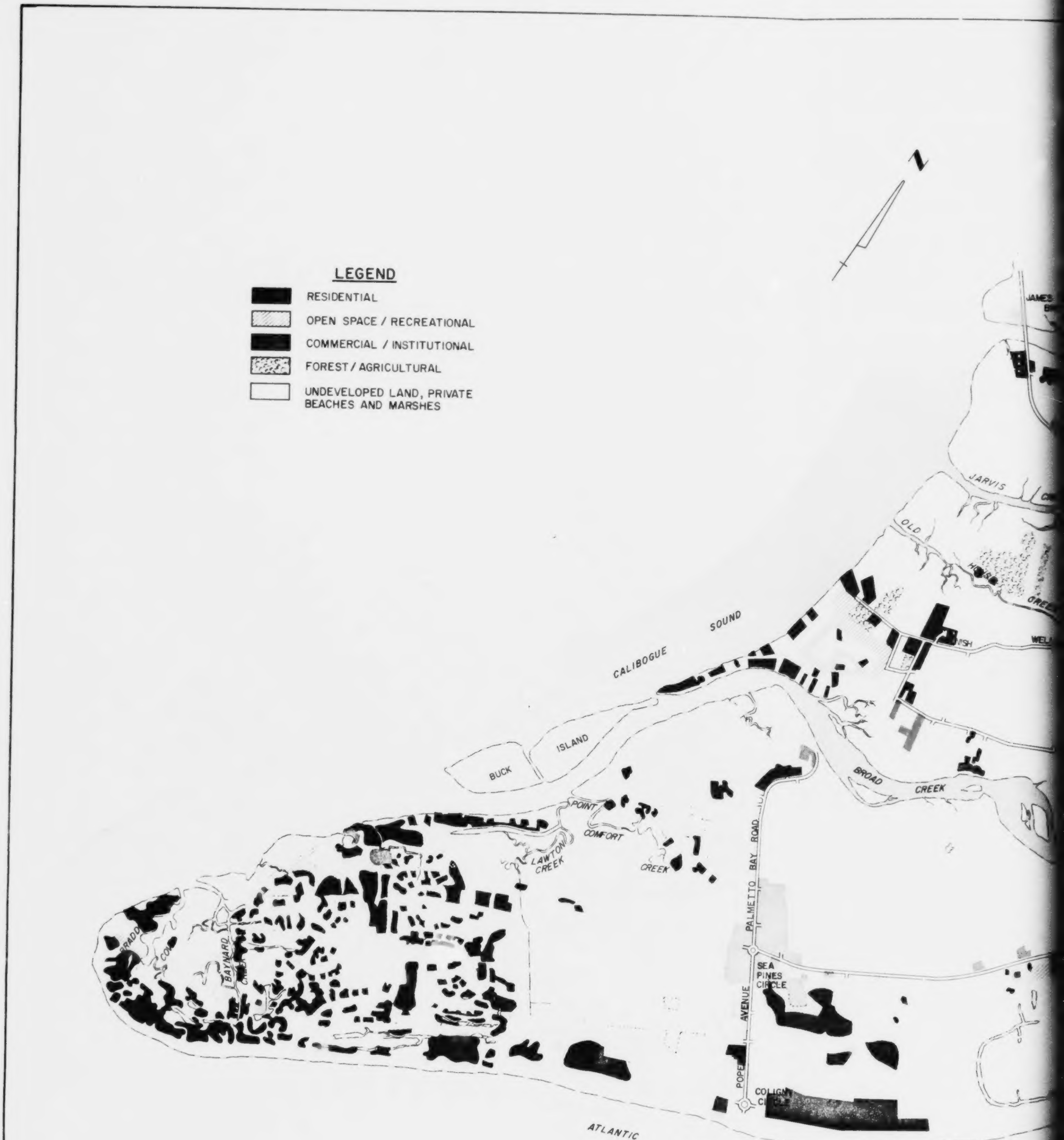
Prior to development, forestry and agriculture were major land uses on the island. These categories have currently shrunk to 214 acres. Due to the rising cost of land, these land uses will probably soon prove uneconomical.

UNDEVELOPED ACRES

Seventy percent, or 19,544 acres of Hilton Head remains undeveloped. Marshes comprise 4,308 acres and are largely protected from development by the Beaufort County Development Standards Ordinance, the South Carolina Coastal Council permitting regulations, and other pieces of Federal legislation. Vacant lands will be addressed in the Future Land Use Section of this report.

SUMMARY

The existing land use patterns on Hilton Head Island, as previously discussed, are shown in Plate III-B-1.


LEGEND
RESIDENTIAL
OPEN SPACE / RECREATIONAL
COMMERCIAL / INSTITUTIONAL
FOREST / AGRICULTURAL
UNDEVELOPED LAND, PRIVATE BEACHES AND MARSHES
N
CALIBOGUE SOUND
BUCK ISLAND
JARVIS
OLD HOUSE CREEK
BROAD CREEK
POINT COMFORT CREEK
LAWTON CREEK
BAYNARD
PALMETTO BAY ROAD
SEA PINES CIRCLE
POPE AVENUE
COLIGNY CIRCLE
ATLANTIC OCEAN

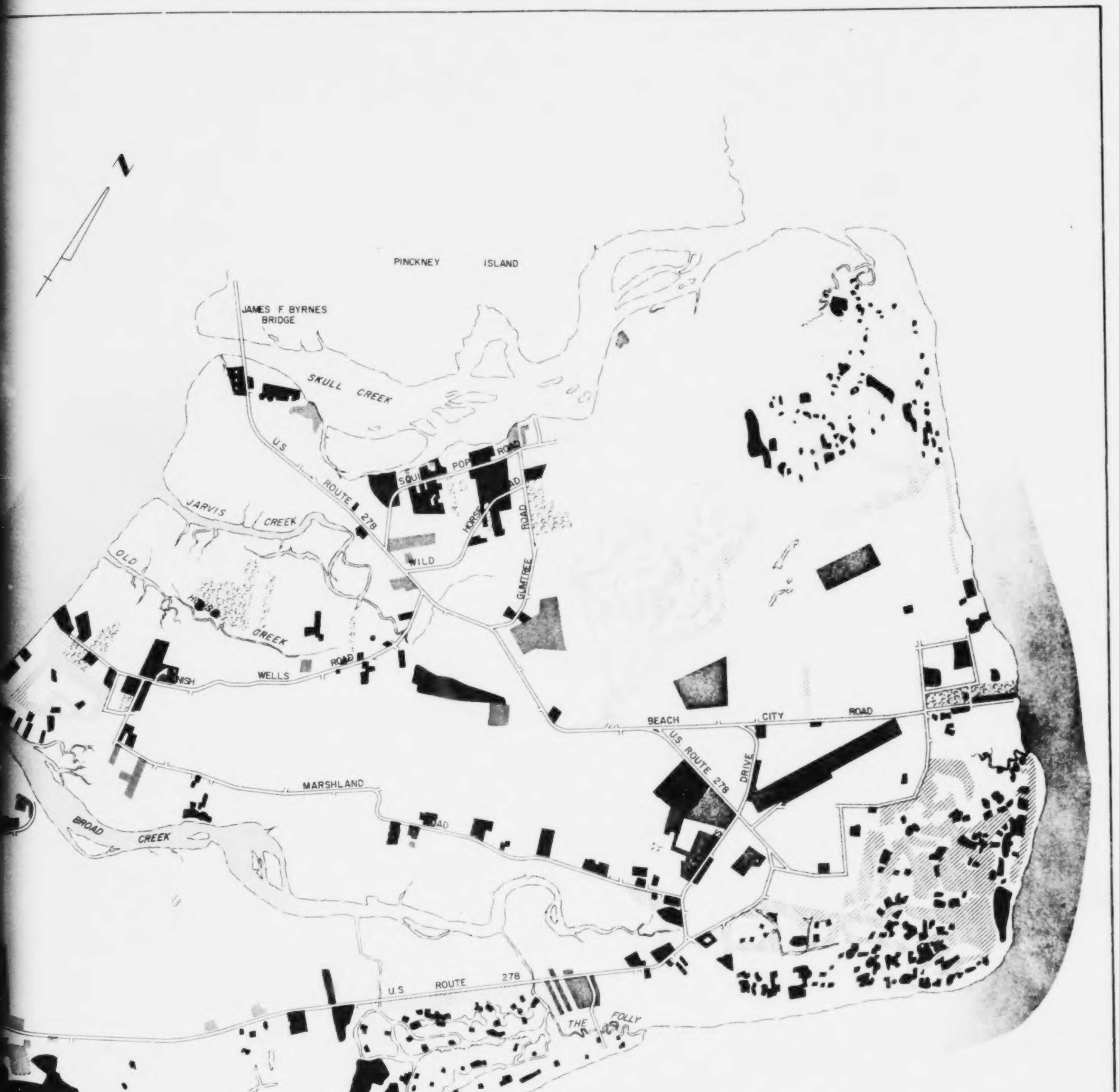

N
PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
SQUIRE POPE ROAD
US ROUTE 278
JARVIS CREEK
WILD HORSE ROAD
GUMTREE ROAD
OLD HOUSE CREEK
SPANISH WELLS ROAD
BEACH CITY ROAD
U.S. ROUTE 278
DRIVE
MARSHLAND ROAD
BROAD CREEK
U.S ROUTE 278
THE FOLLY
3000 0 3000 6000
SCALE IN FEET

PLATE III - B - I

HILTON HEAD ISLAND
SOUTH CAROLINA

EXISTING LAND USE

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

CHAPTER III-C

FUTURE LAND USE

As shown in Figure III-B-1 ("Existing Land Use" - Chapter III-B), 14,561 acres, or 52.2 percent, of the island is classified as vacant land and can be considered to have development potential, subject to detailed engineering surveys. The rate and location of future development on the island will come about in response to private market conditions and the availability of public utilities. The most critical of these services is wastewater facilities.

Approximately 17,500 of the island's 28,000 acres, or 63.0 percent, are currently owned by plantation developers, all of whom have filed masterplans with the Beaufort Joint Planning Commission. Estimates of the number of dwelling units to be eventually constructed and numbers of acres per land use category can be derived from these masterplans with reasonable accuracy.

The remaining 10,500 acres are owned by individuals or non-plantation developers, and approximately 2100 acres of this land are currently developed. Because these areas are not masterplanned, it is extremely difficult to predict their rate of development and ultimate land uses.

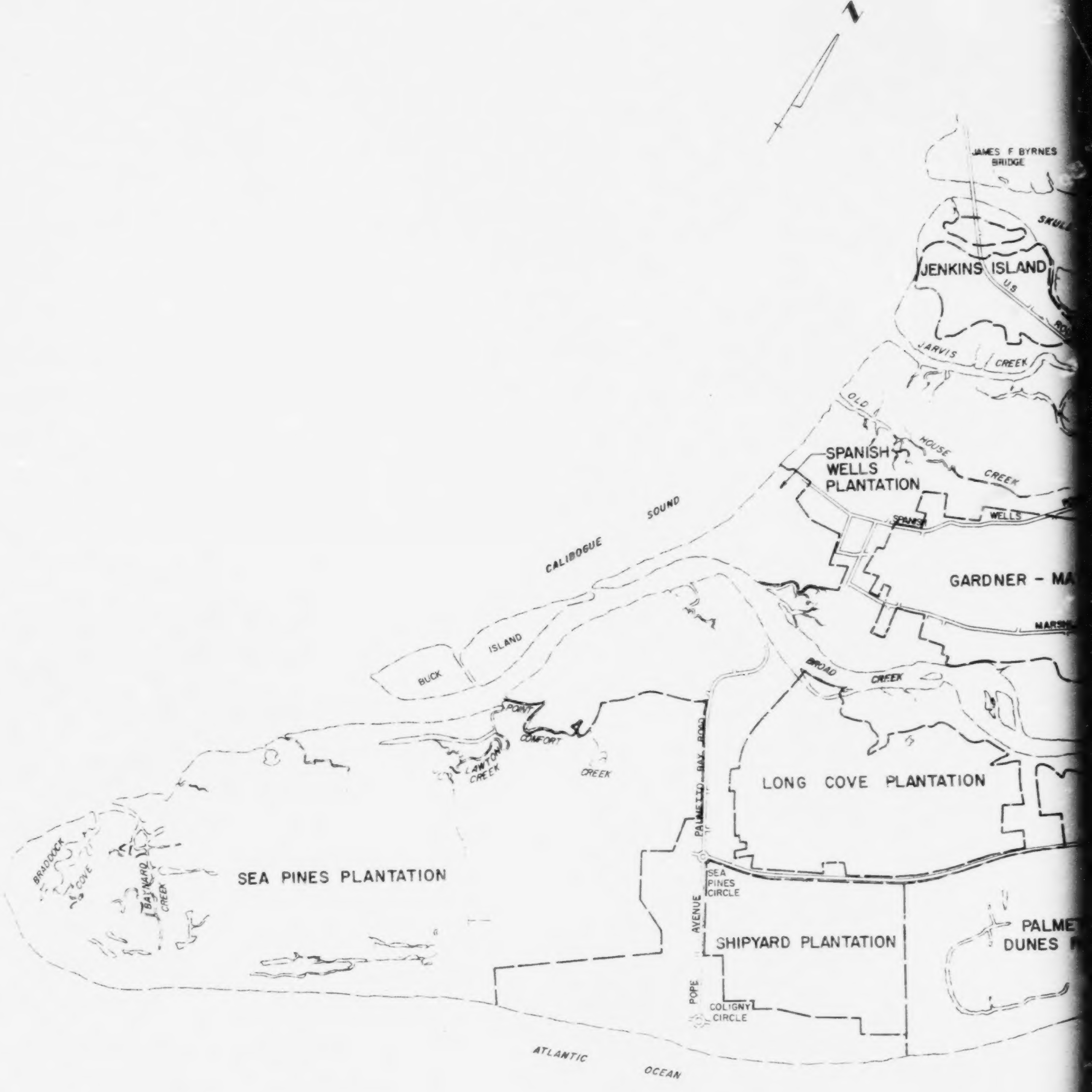
The following sections of this chapter discuss what can be ascertained or estimated about future land uses in plantation and non-plantation areas. These areas are illustrated in Plate III-C-1.

PLANTATION AREAS

Examination of masterplans and interviews with plantation developers form the basis for assembling the data shown in Table III-C-1. In several cases, the figures are estimates, but they fall within reasonable ranges. Typically, transportation corridors account for eight to 10 percent of land area. Open space and recreation land uses range from 26 to 57 percent of total area and average 41 percent for all plantations.

In late November, 1979, Palmetto Dunes Resort's undeveloped acreage was sold to Greenwood Development Corporation in association with Charles Fraser and Robert Onorato. The three tracts include 415 acres south of the developed portion of Palmetto Dunes Resort fronting on the Atlantic Ocean, 230 acres across Highway 278 fronting on Broad Creek, and an area of 1100 acres on the north end of the island adjacent to Hilton Head Plantation known as Palmetto Dunes Highlands.

Low density residential areas are those containing one to four units per acre. Medium density residential areas contain five to 10 units per acre. High density residential areas contain over 10 units per acre and generally are built out as resort accommodations such as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OLD HOUSE CREEK
SPANISH WELLS PLANTATION
SPANISH WELLS
CALIBOGUE SOUND
GARDNER - MA
MARSH
BUCK ISLAND
BROAD CREEK
POINT COMFORT CREEK
LAWTON CREEK
PALMETTO BAY ROAD
LONG COVE PLANTATION
BRADDOCK COVE
BAYNARD CREEK
SEA PINES PLANTATION
SEA PINES CIRCLE
AVENUE
POPE
SHIPYARD PLANTATION
PALMET
DUNES P
COLIGNY CIRCLE
ATLANTIC OCEAN

III-C-2a

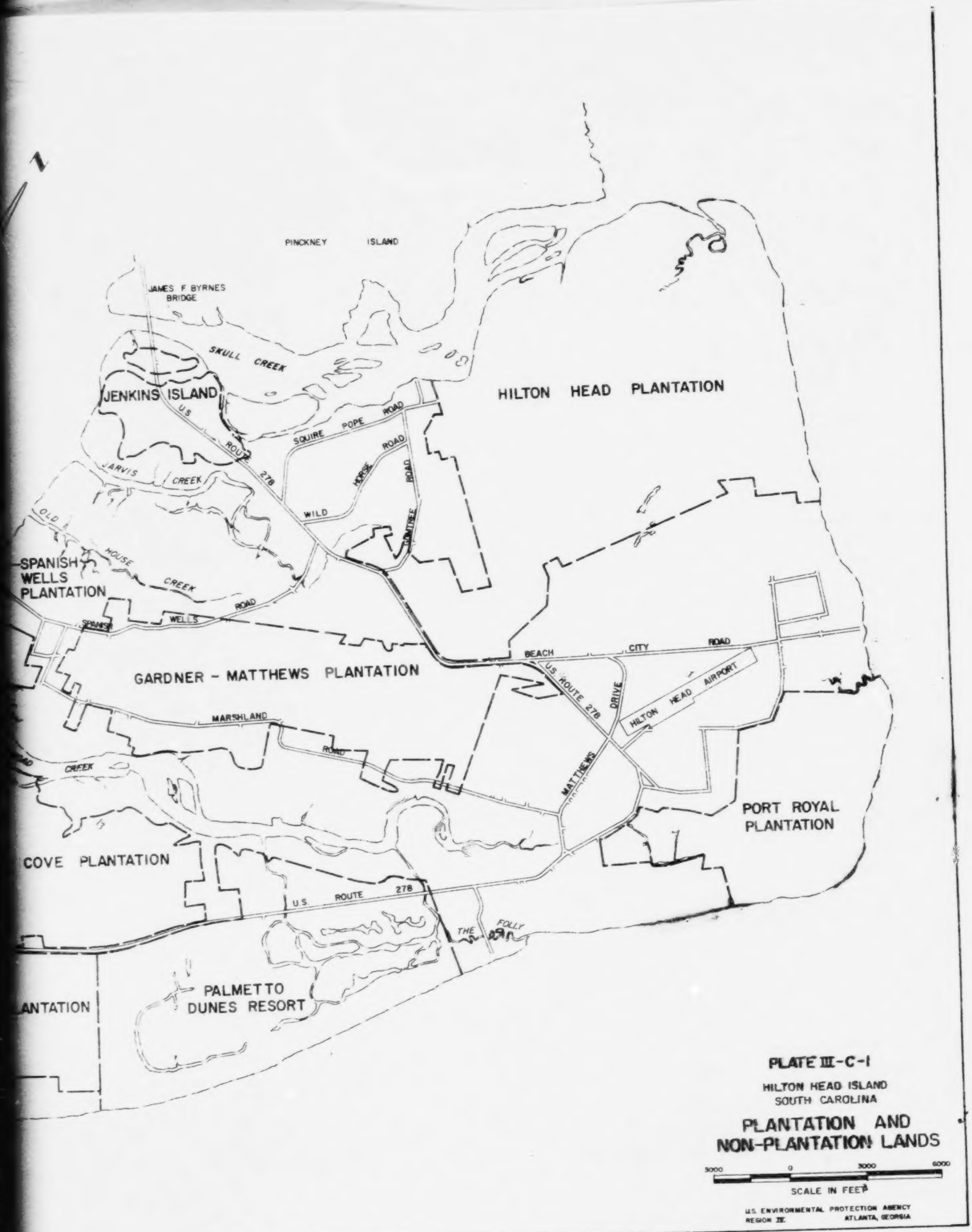
PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
JENKINS ISLAND
HILTON HEAD PLANTATION
US ROUTE 278
SQUIRE POPE ROAD
WILD HORSE ROAD
GUMTREE ROAD
JARVIS CREEK
OLD HOUSE CREEK
SPANISH WELLS PLANTATION
SPANISH WELLS ROAD
BEACH CITY ROAD
GARDNER - MATTHEWS PLANTATION
U.S. ROUTE 278
HILTON HEAD AIRPORT
MATTHEWS DRIVE
MARSHLAND ROAD
CREEK
PORT ROYAL PLANTATION
COVE PLANTATION
U.S. ROUTE 278
THE FOLLY
PALMETTO DUNES RESORT
LANTATION
3000
0
3000
6000
SCALE IN FEET

PLATE III-C-1

HILTON HEAD ISLAND
SOUTH CAROLINA

PLANTATION AND NON-PLANTATION LANDS

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

TABLE III-C-1

PLANTATION FUTURE LAND USE IN ACRES (NO DATE)

Plantation	Residential by Density Low	Med	High	Commercial	Industrial/ Utility	Institutional	Open Space & Recreation	Trans	Unknown	T
Jenkins Island		145.4		14.7		26.6	75.3	31.0		2
Gardner-Matthews	288.8	557.0		72.3	215.2	10.9	563.7	157.6		18
Long Cove	369.8	195.3		94.9	44.1	0.0	494.1	146.2		13
Shipyard	189.3	179.2	8.8	84.5		1.7	295.9	76.0		8
Port Royal	520.1	11.0	15.0	1.0			733.9	*		12
Hilton Head	1382.0	73.0	85.0	107.0	40.0	5.0	1894.0	332.0		39
Sea Pines	1622.0		30.0	105.0	36.0	15.0	2335.0	357.0		45
Palmetto Dunes I	585.0		10.0		35.0		600.0	125.0		13
Palmetto Dunes II (oceanside)									415.0	4
Palmetto Dunes III (marsh side)									230.0	2
Palmetto Dunes Highlands									1100.0	11
Spanish Wells	200.0						195.0	40.0		4
TOTAL	6327.9		138.8	479.4	370.3	59.2	7186.9	1264.8	1745.0	17

*Roads were not given as a separate land use.

Source: Sea Pines Company, Hilton Head Company, Hilton Head Plantation, Claude Terry & Associates, Inc.

hotels, inns, mid-rise apartments, and similar architectural forms. Hotels and inns are constructed or planned for Shipyard, Port Royal, Palmetto Dunes I, and Sea Pines. Hilton Head Plantation has set aside a tract bordering Skull Creek for high density development but at this time does not know the form it will take. Residential acreage ranges between 37 and 66 percent of each plantation's total area but more typically runs between 43 and 50 percent.

Table III-C-2 addresses the issue of how many dwelling units are planned for eventual construction by plantation developers. Currently, the total proposed is approximately 29,592 units. This information has been derived from masterplans which are public documents and from interviews with developers.

Given nearly 30,000 dwelling units, the next step was to estimate the numbers of persons who possibly might inhabit these units. In many communities, 3.2 persons/unit is a reasonable statistic. However, this figure is probably too high for Hilton Head Island plantation dwellers based on the large number of retirees who are permanent residents. An estimate of 2.2 persons/unit is probably too low unless a given plantation constructs a very high proportion of units as hotel bedrooms. Presently, Sea Pines Plantation's management estimates their statistics to be 2.47 persons/unit. Therefore, it becomes reasonable to assume that the future average for all plantations (who may have fewer retirees than Sea Pines) will come close to 2.9 persons/unit. In other words, the number of persons

TABLE III-C-2

ULTIMATE NUMBER OF PLANTATION DWELLING UNITS AND POTENTIAL RESIDENTS (NO DATE)

Plantation	# of Units by Density:			Population if Persons/Unit Equals:			
	Low	Med	High	3.2	2.9	2.5	2.2
Jenkins Island		1163		3,722	3,373	2,908	2,559
Gardner-Matthews	722	4482*		16,653	15,092	13,010	11,449
Long Cove	502	1550		6,566	5,951	5,130	4,514
Shipyard	251	1219	341	5,795	5,252	4,528	3,984
Port Royal	849		450**	4,157	3,767	3,248	2,858
Hilton Head***	3210	807	2045	19,398	17,580	15,155	13,336
Sea Pines	3790	2100	494	20,429	18,514	15,960	14,045
Palmetto Dunes I	1,011	854	760	8,400	7,613	6,563	5,775
Palmetto Dunes II (oceanside)	Assume 40% of 1745 acres will be residential. Assume average of 4 units/ acres. Assume 2792 dwelling units.			8,934	8,097	6,980	6,142
Palmetto Dunes II (marshside)							
Palmetto Dunes Highlands							
Spanish Wells	200			640	580	500	440
TOTAL	29,592			94,694	85,819	73,980	65,102

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*Includes 3482 multifamily units, an estimated 500 mobile homes, and an estimated 500 recreational vehicles.

**Estimated number of rooms in future hotel plus Port Royal Inn.

***Only 2885 units will be built by the year 2000.

Source: Sea Pines Company, Hilton Head Company, Hilton Head Plantation, Palmetto Dunes Resort, Claude Terry & Associates, Inc.

who could be housed at full occupancy approaches 86,000 individuals at some unknown date. Considering that the peak population estimate in the year 2000 is approximately 65,000 persons, it is safe to assume that all plantations will not be built out as currently proposed until well into the twenty-first century, if nothing occurs to constrain existing masterplans.

Few developers are willing to estimate the degree to which their plantations will be built out by the year 2000. Sea Pines Plantation, which has completed or has under construction 3572 (60.7 percent) of its total 5,890 units enforced by legal covenants, expects to have completed development by the end of the century. Hilton Head Plantation has estimated its construction schedule in five-year increments, and this information is shown in Table III-C-3. Other plantation developers have not committed to a schedule.

NON-PLANTATION AREAS

Less can be predicted about non-plantation areas than plantation areas during the next 20 years. Commercial development will increase along Highway 278 in response to population growth. Much of the new commercial development will take place at the northern end of the island to serve a growing resort and residential base in that area.

Much of the undeveloped non-plantation land located in the northern half of the island is known as Heir's Property (The Beaufort

TABLE III-C-3

HILTON HEAD PLANTATION CUMULATIVE BUILD-OUT 2000

Year	Dwelling Units	Population if persons/unit equals:	
		2.9	2.5
1980	385	1117	963
1985	760	2204	1900
1990	1385	4016	3463
1995	2135	6192	5338
2000	2885	8367	7213

Source: Hilton Head Plantation; November, 1979 and Claude Terry & Associates, Inc.

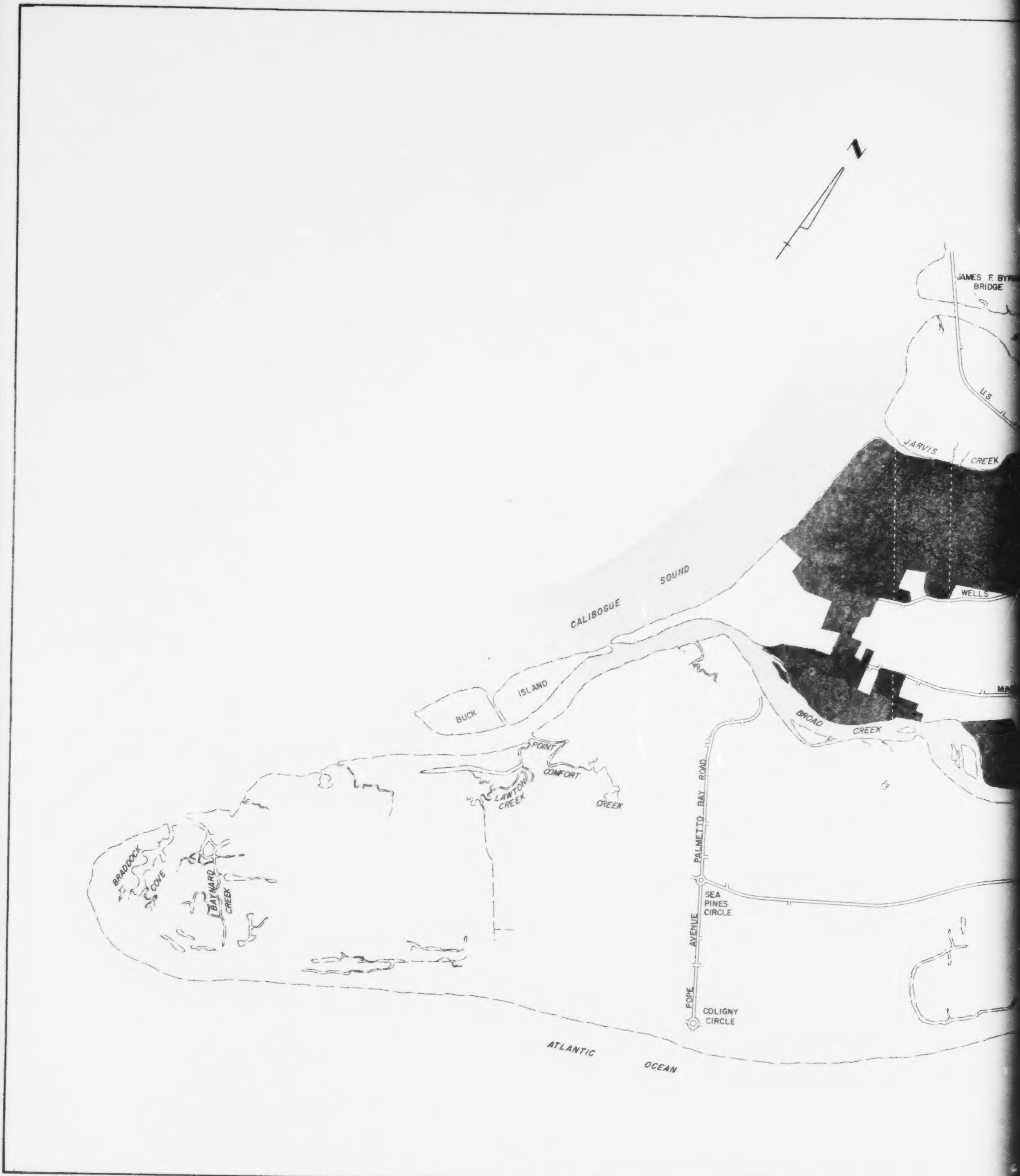
Joint Planning Commission is not able to furnish acreage figures at this time). These tracts date back to the allocation of 47-acre parcels to black families during Reconstruction. The locations of the larger black communities are shown in Plate III-C-2.

During the past hundred years, these tracts have passed with divided and undivided interest to the heirs of the original property owners. In many instances, titles are now unclear, and the task of assembling parcels into large enough tracts to warrant significant development is extremely cumbersome under South Carolina law. As a consequence, the development potential of Heir's Property is severely constrained at this time. The black community's difficulties encountered in participating in the capital appreciation of the island's land has had social and political repercussions.

In addition to title problems, most of the Heir's Property is not served by a Public Service District and consequently is unsewered (See Plate III-J-1 of "Wastewater Programs" - Chapter III-J). Based on state law regarding the size of lots using on-lot wastewater disposal methods, Heir's Property land will continue to remain in low-density residential uses until such time as sewer service is available and the land becomes attractive to developers. The capital costs of providing wastewater management services to these areas and the ability of the population served to meet connection fees and user charges is a significant concern of black community leaders.

SUMMARY

Future land use for Hilton Head Island, as previously discussed, is shown in Plate III-C-3.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BROAD CREEK
POINT COMFORT CREEK
LAWTON CREEK
PALMETTO BAY ROAD
SEA PINES CIRCLE
POPE AVENUE
COLIGNY CIRCLE
BRADDOCK COVE
BAYNARD CREEK
ATLANTIC OCEAN

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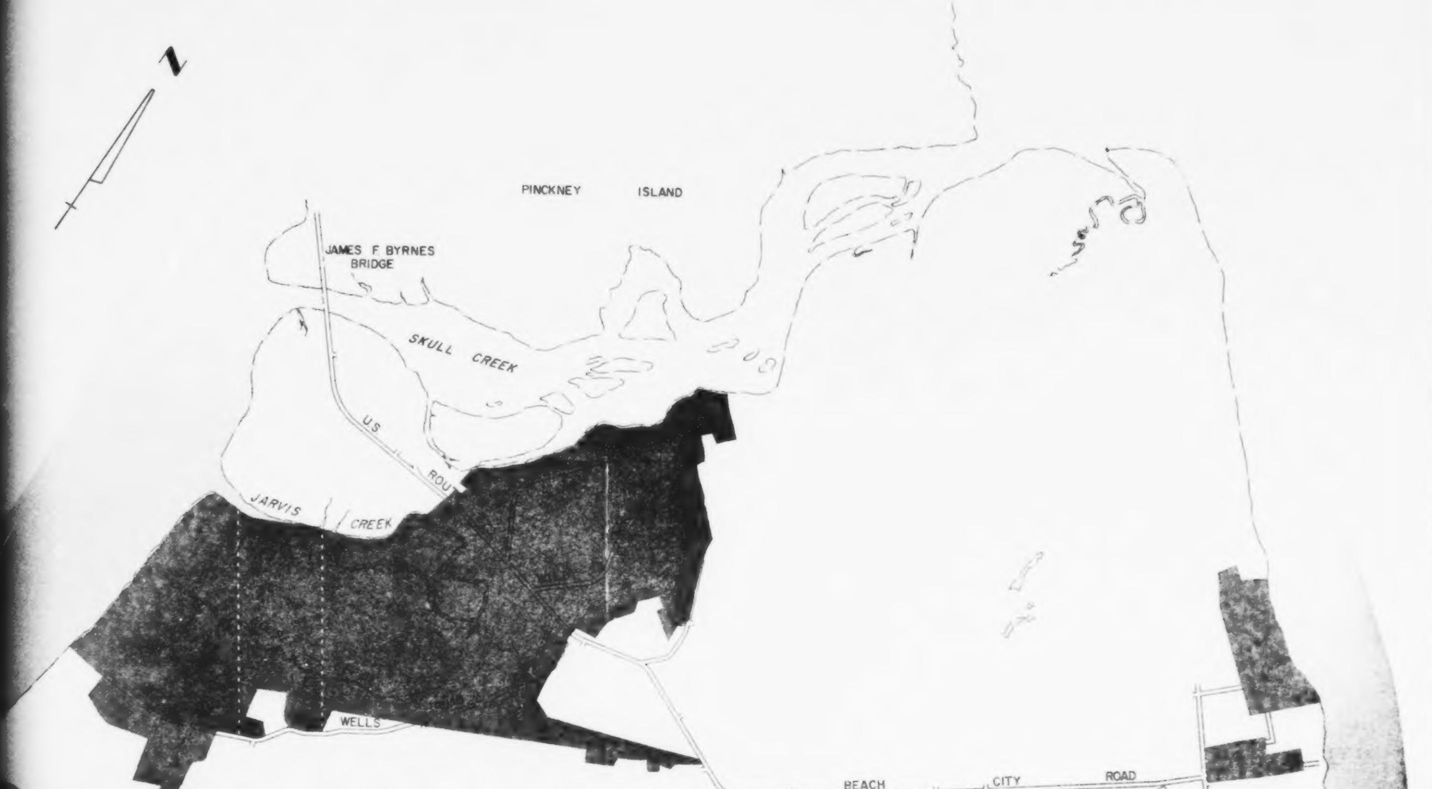
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JAMES F BYRNES BRIDGE
SKULL CREEK
U.S. ROUTE
JARVIS CREEK
WELLS
BEACH CITY ROAD
U.S. ROUTE 278
DRIVE
HILTON HEAD AIRPORT
MARSHLAND
BROAD CREEK
U.S. ROUTE 278

PLATE III-C-2

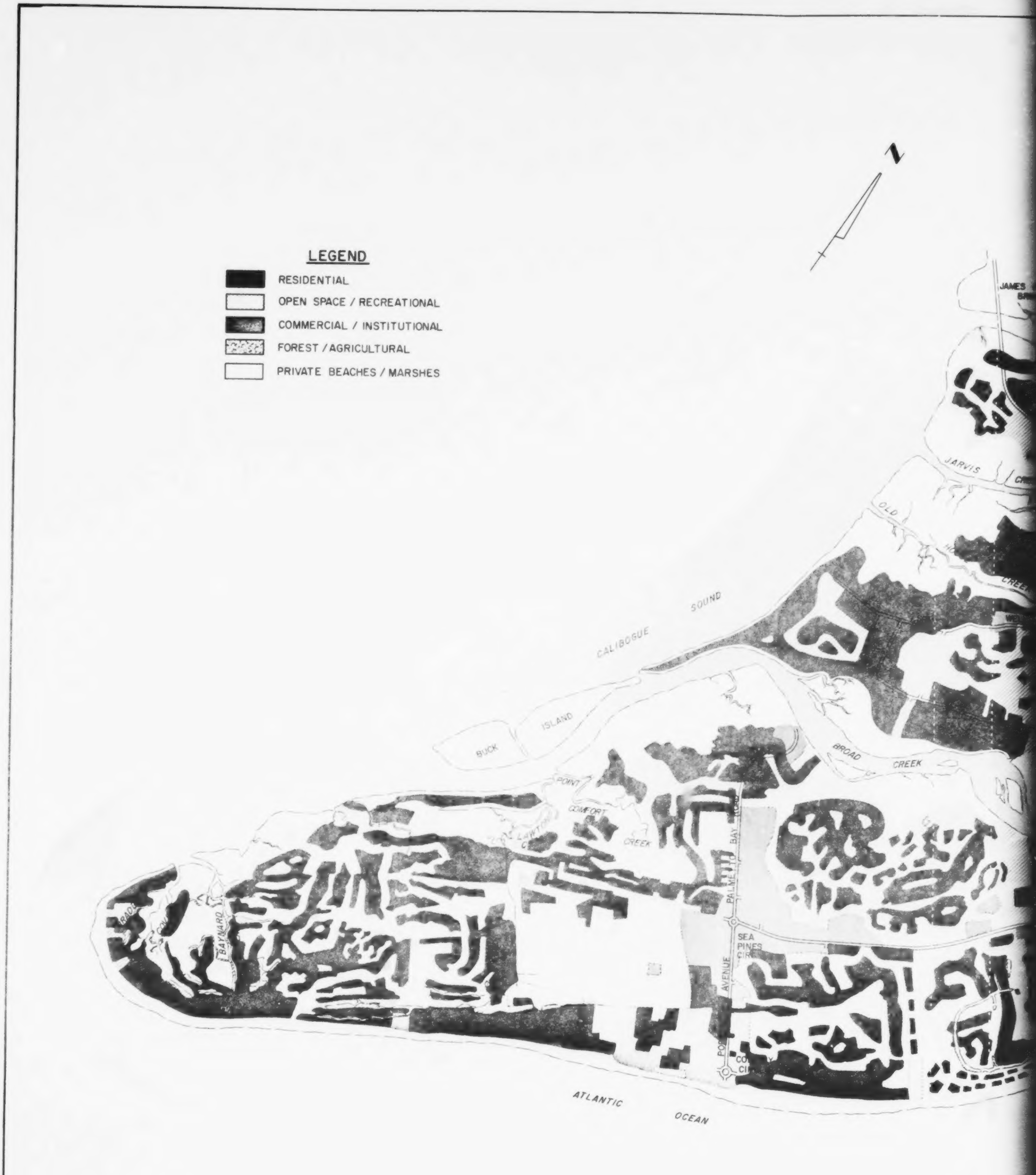
HILTON HEAD ISLAND
SOUTH CAROLINA

GENERALIZED HEIR'S PROPERTY MAP

3000 0 3000 6000
SCALE IN FEET

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

III-C-9-b


LEGEND
RESIDENTIAL
OPEN SPACE / RECREATIONAL
COMMERCIAL / INSTITUTIONAL
FOREST / AGRICULTURAL
PRIVATE BEACHES / MARSHES
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JAMES
JARVIS
OLD
CREEK
CALIBOGUE SOUND
BUCK ISLAND
BROAD CREEK
POINT COMFORT CREEK
LAWTON
BAYNARD
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SEA PINES CIR
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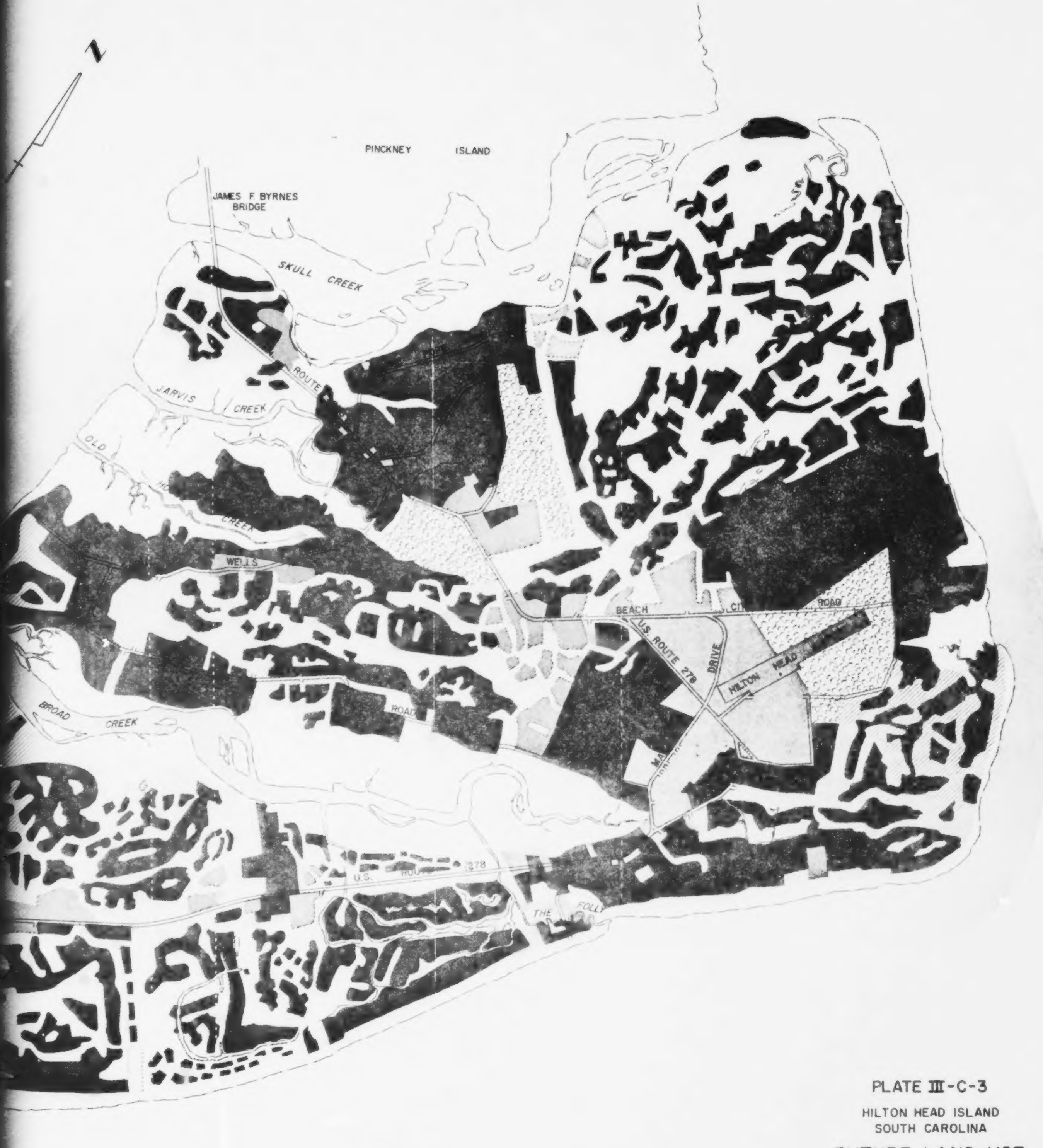
ATLANTIC OCEAN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BRIDGE
SKULL CREEK
ROUTE
JARVIS CREEK
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CREEK
WELLS
BEACH
CITY
ROAD
U.S. ROUTE 278
DRIVE
HILTON HEAD
BROAD CREEK
ROAD
MA
U.S. ROUTE 278
THE FOLLY

PLATE III-C-3

HILTON HEAD ISLAND
SOUTH CAROLINA

FUTURE LAND USE

3000 0 3000 6000

SCALE IN FEET

US ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

CHAPTER III-D

EXISTING DEVELOPMENT CONTROLS

Land development controls are an important aspect of water quality management planning. Land use regulations can be used to direct development away from sensitive environmental areas, including water quality sensitive areas. Land use controls can also serve to mitigate any short-term or long-term negative impacts that may result from the provision of wastewater treatment and disposal facilities.

The discussion that follows is a summary review of federal, state and local laws relating to land use control and environmental preservation. It focuses upon local ordinances and regulations since they are potentially the most effective means for dealing with many of the development and environmental issues which have been raised during the EIS study public participation process.

LOCAL CONTROLS

Act 487 of South Carolina Acts of 1967 gives counties and municipalities the authority to establish planning commissions and prepare comprehensive plans for their jurisdictions. The Beaufort Joint Planning Commission was established in February 1969 and has the power to plat land, enact zoning ordinances, and provide other development controls in Beaufort County and its municipalities.

Hilton Head Island is part of unincorporated Beaufort County and subject to the county's development controls. The Cities of Beaufort and Port Royal have adopted zoning ordinances, but the county has not. A referendum on county-wide zoning failed to pass in 1974. Hence, there is currently no zoning on Hilton Head Island.

Two major pieces of legislation affect development on Hilton Head Island. The first is the Beaufort County Development Standards Ordinance (DSO), which was adopted in the fall of 1978. It replaced the Beaufort County Subdivision Regulations, which had been adopted in 1974. The second is the permitting rules and regulations of the South Carolina Coastal Council, which became effective in May 1978.

It is generally agreed on the island and among Beaufort County officials that additional development controls are needed. The form these controls should take is a matter of debate. Beaufort County officials believe that the first step in reaching a decision is to develop an island-wide land use plan to serve as a policy statement about future development and population distribution. The Joint Planning Commission has allocated funding and a staff member for this task and initially expected to complete the Land Use Plan by June 30, 1980. However, the JPC Executive Director has subsequently decided to await the findings of the EIS. Thus, the Land Use Plan will probably be completed in late 1980. The specific mechanisms for implementing the Land Use Plan will be considered at that time.

The following sections of this chapter discuss the provisions, strengths, and weaknesses of the Development Standards Ordinance and the Coastal Council permitting system.

Development Standards Ordinance Provisions

For purposes of the ordinance, "development" is defined as:

1. A material change in type of use of a structure or land which would tangibly affect the area's natural environment, transportation patterns, public health, or economic values.
2. A building operation involving construction, reconstruction, or alteration of the size of a structure which would result in a tangible effect on the area's natural environment, transportation patterns, public health, or economic values.
3. A material increase in the intensity of land use such as an increase in the number of businesses, manufacturing establishments, offices or dwelling units in a structure or on land, when such increase would tangibly affect the area's natural environment, transportation patterns, public health, or economic values.
4. Commencement of any mining operation on a parcel of land.
5. In connection with the use of land, the making of any material change in noise levels, thermal conditions, or emissions of waste material.

6. Alteration of a shore, bank, or flood plain of a seacoast, river, stream, lake, or other natural water body.
7. Re-establishment of a use which has been abandoned for one year.

Exemptions to the ordinance include public works projects (which are under the jurisdiction of separate administrative procedures), agricultural practices, routine maintenance of structures, subdivision of raw land, and assemblage of small parcels into a larger tract. Any subdivision, construction, changes, or improvements approved by the county prior to adoption of the ordinance in September 1978 are also exempt.

The ordinance establishes three special districts: the Conservation District; the Beach Development District; and the Flood Hazard District.

The Conservation District is composed of all wetland areas and is delineated on the Official Map by the following criteria:

1. Any salt, brackish, or fresh water marsh, bog, swamp, meadow, flat, or other area subject to tidal flow, whether or not the tidewater reaches the area naturally or through artificial water courses;

2. Any other areas upon which exist a natural community of one or more of the following marsh grass indicators of tidal influence: *Spartina alterniflora*, *Spartina patenas*, and *Juncus roemerianus*; and,

3. Any natural land-locked bogs, swamps, lakes, ponds, sinks, or low-lying areas determined to be unique or important wildlife habitats, or to possess unique scenic and recreational value.

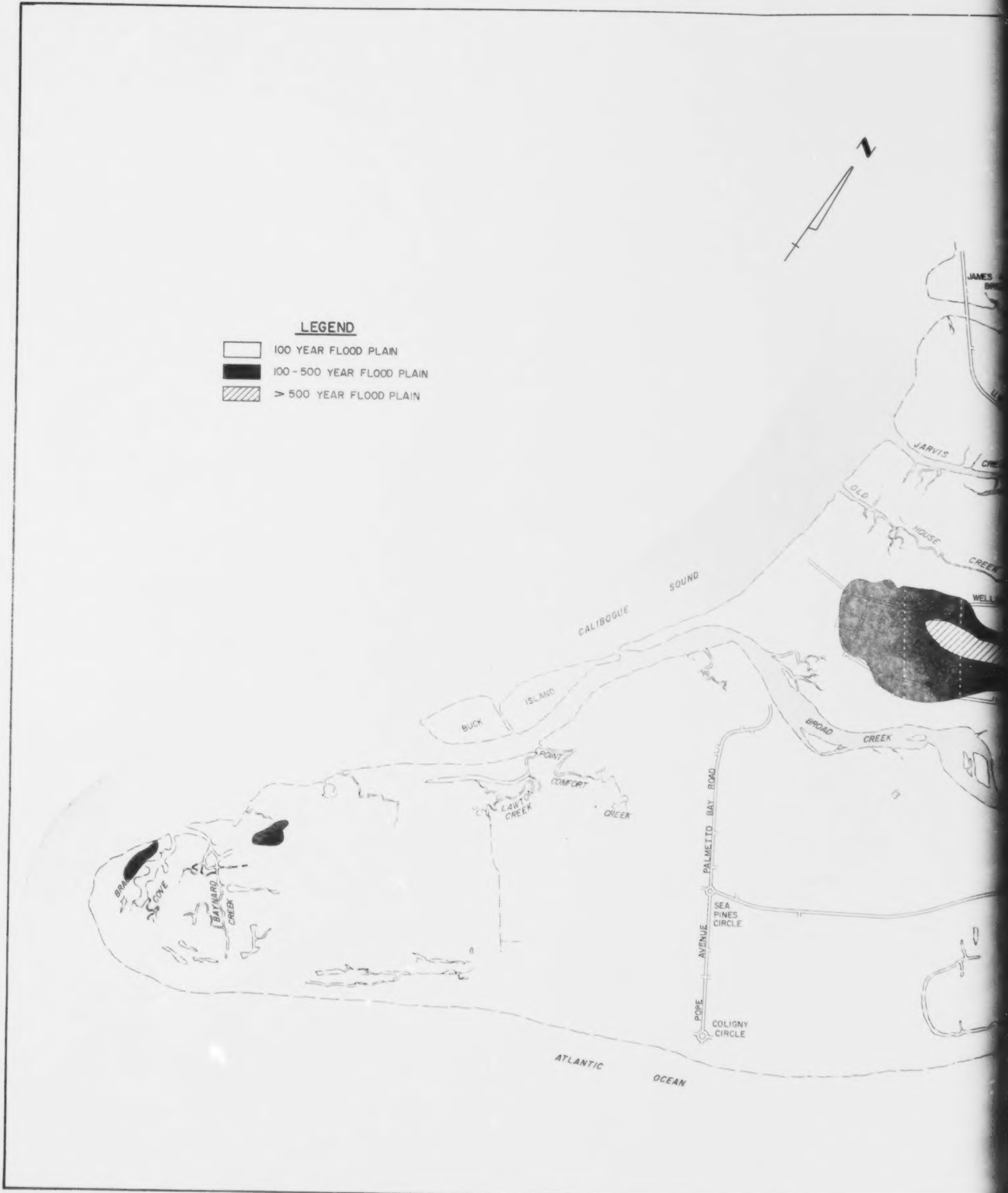
Specific exception from a designation of Conservation District was granted to planned developments (Sea Pines, Palmetto Dunes Resort, and Hilton Head Plantation) whose masterplans had been preliminarily approved by the county prior to adoption of the DSO, or whose development was specifically excepted or preliminarily approved under the old Beaufort County Subdivision Regulations. For this reason, the location of wetlands on Hilton Head Island shown by the Conservation District Maps do not entirely correspond with wetlands delineated by the National Wetlands Inventory (USFWS 1979). Generally there is very close agreement with the mapping of saltwater wetland types, but the National Wetlands Inventory shows a much greater extent of freshwater wetland types than is shown by the Conservation District maps (see discussion in Chapter II-I - "Ecological Inventory: Wetland Regulations"). Apparently these discrepancies are due to the exempted areas in previously planned developments on Hilton Head.

The Beach Development District conforms with the "primary ocean front sand dunes" area of the South Carolina Coastal Council's permitting authority and is specially defined as follows:

1. To the landward trough of the primary front row sand dune if the crest of this dune is reached within 200 feet landward from mean high water;
2. To the seaward side of any maritime forest or upland vegetation if reached before the primary front row sand dune; and,
3. To the seaward side of any permanent man-made structure which was functional in its present form on the date of adoption of the DSO where such structure is located seaward of any primary dune and within 200 feet of mean high water.

The Flood Hazard District is composed of those areas designated as flood-prone by the Federal Emergency Management Agency. Plate III-D-1 shows the location of flood-prone areas.

Unlike a zoning ordinance, districts are not established for residential, commercial, industrial, institutional, recreational, or agricultural land uses. Instead, minimum construction standards and site design criteria are set forth. The ordinance addresses performance standards for setbacks; streets; rights of way and pavements; parking and loading; provision of utilities, drainage, planning and design certification; preservation of vegetation; erosion control; pollution and nuisance control; and open space provisions.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JAMES
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OLD
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CREEK
WELL
CALIBOGUE
SOUND
BUCK
ISLAND
BROAD
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POINT
COMFORT
CREEK
LAWTON
CREEK
PALMETTO BAY ROAD
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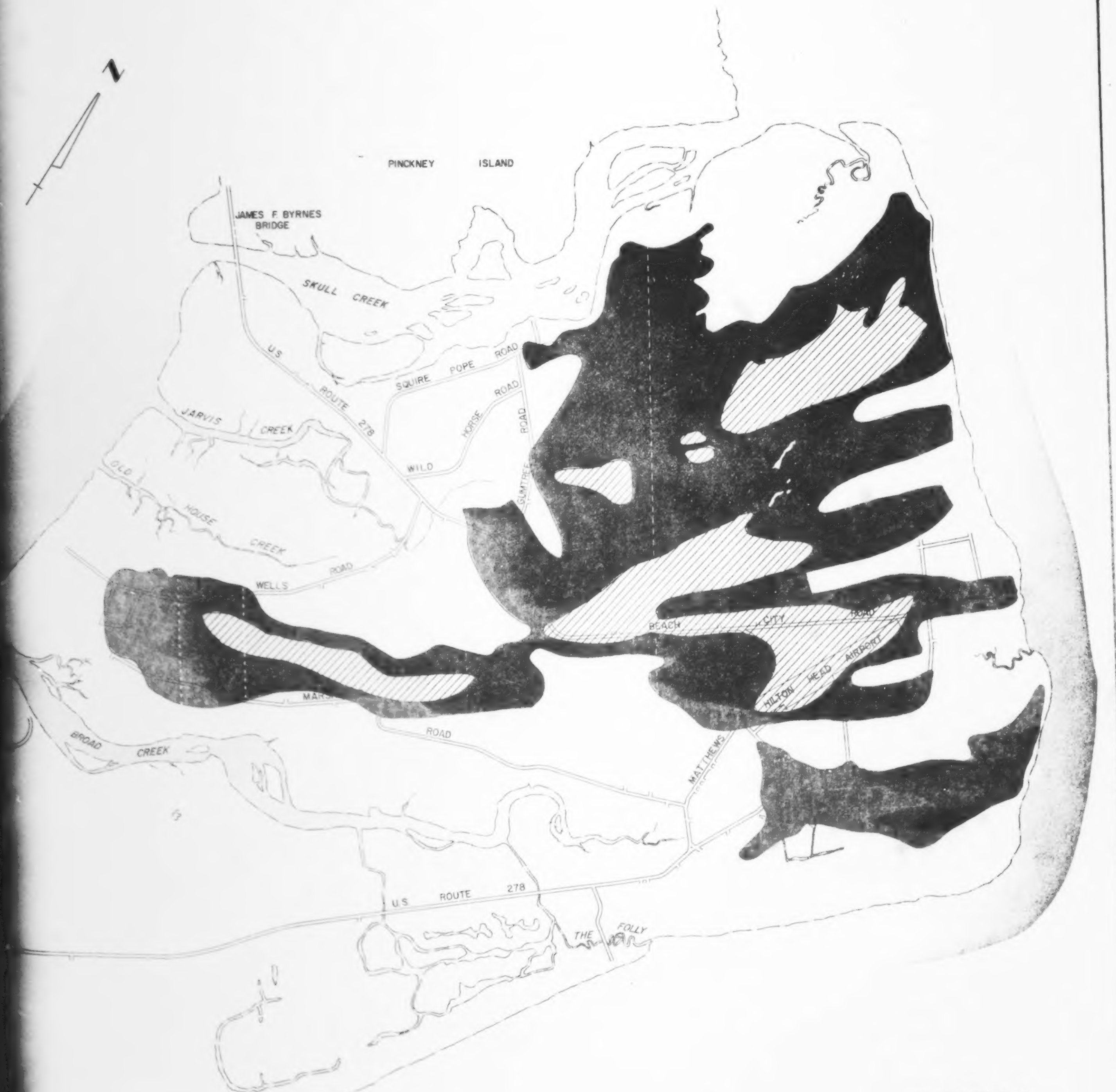
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SKULL CREEK
US ROUTE 278
SQUIRE POPE ROAD
WILD HORSE ROAD
GUMTREE ROAD
JARVIS CREEK
OLD HOUSE CREEK
WELLS ROAD
MARS
ROAD
BROAD CREEK
BEACH CITY ROAD
HILTON HEAD AIRPORT
MATTHEWS
U.S ROUTE 278
THE FOLLY

PLATE III-D-1

HILTON HEAD ISLAND
SOUTH CAROLINA

FLOOD PRONE AREAS

3000 0 3000 6000
SCALE IN FEET

U.S ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

Additional standards apply to the three special districts. Standards prohibit disruption of tidal flows, require options for the County to purchase public beach access, protect sand dunes and their vegetation, and set forth flood hazard design specifications and disclosure statements.

The DSO contains sections detailing development permitting procedures. The Beaufort Joint Planning Commission administers the permitting process and specifies the contents of the preliminary and formal application packages. Special provisions are made for planned unit developments which may be developed in phases by several different developers. Appeals and public hearings are provided, and the means of enforcement and amendment are specified.

DSO Analysis

The DSO is not a zoning ordinance, nor did its framers intend it to be one. However, much of the islanders' frustration with the DSO stems from the popular misconception that the DSO would provide the same type of development controls that a zoning ordinance does. Therefore, some factions are promoting the development of a zoning ordinance as the solution to the island's growth problems. Others favor strengthing the DSO and adding to its special districts.

This latter alternative is most actively promoted by Charles Fraser, Chairman of the Board of the Sea Pines Company. Since April, 1979, he has circulated a memo and its revisions to island groups and Beaufort County officials proposing the establishment of Hilton Head as an urban district. As a first step, he proposes that certain types of commercial establishments be declared public nuisances on the island and in a five-mile corridor along Highway 278 beyond Byrnes Bridge. These uses could only exist if buffered according to specific standards. Other sections of the proposal address greenspace around resort lodgings, building height limits, strip development controls, setback requirements, commercial sign control, extension of covenants providing single-family home land uses, a mechanism to issue bonds for buying park lands, and provision of moderate cost housing. As a second step, Fraser proposes the development of a comprehensive growth management ordinance backed by extensive research into the environmental carrying capacity of the island.

Other frustrations with the existing DSO are administrative in nature. A four-part series of articles in The Packet published during October 1979 discusses the efficiency, effectiveness, and equity of the administration of the DSO by the JPC commissioners and staff. Further articles in January 1980 document concern over the fact that the Beaufort County Building Inspection Department does not have a staff large enough to monitor DSO violations and enforce provisions of the ordinance.

Twelve citizen commissioners serve on the JPC and are supported by a staff of three planners and a secretary. When the JPC was formed in 1969, it was charged with undertaking long-range planning for the county's development. The Executive Director, the secretary, and the commissioners now find that their time is consumed by reviewing developers' DSO permit applications, and that consequently their ability to do long-range planning is seriously restricted. On the other hand, developers claim that it takes too much time for the JPC to review their applications and that some of the required information is not necessary.

Plantation developers filed master plans for Sea Pines, Palmetto Dunes Resort, and Hilton Head Plantation with the county before subdivision regulations and the DSO were enacted. These three developments are therefore exempted from DSO review except in cases where the developers wish to make significant changes. The definition of a significant change is a matter of negotiation between a developer and the JPC. Dissatisfaction has been voiced over this procedure, particularly by developers who cite undue interference in their projects and increased costs of doing business. Questions have arisen about the legality of the grandfather clause since county laws are required to apply equally to all parties.

Another area of dissatisfaction with the DSO is that it does not address location requirements for wastewater treatment plants or other elements of wastewater management systems. This problem was cited by the Lowcountry 208 Areawide Water Quality Management Plan, among other sources.

Summary

The DSO, as it is now administered and enforced, is no longer adequate to solve the problems created by ongoing growth on Hilton Head Island. Beaufort County officials are committed to finding a new growth management mechanism and have authorized the development of a Land Use Plan in order to lay the groundwork for public debate.

STATE CONTROLS

Unlike some neighboring states such as Georgia, South Carolina does not have a group of individual state laws which address marshlands protection, threatened and endangered species, etc. Instead, South Carolina largely relies on the provisions of federal laws which address environmental concerns.

The standards and regulations of the South Carolina Department of Health and Environmental Control serve to maintain water quality. As such, they exercise a degree of control over land development, especially with regard to the location of septic tanks and by extension, the size of residential lots. The South Carolina Coastal Council plays a more direct role in controlling development. This role is described in detail in the following section.

South Carolina Coastal Management Act

The South Carolina Coastal Management Act (Act 123) was passed by the 1977 General Assembly in response to the federal Coastal Zone

Management Act of 1972 so to provide for the protection and enhancement of the State's coastal resources. The legislation created the South Carolina Coastal Council which is given the task of promoting the economic and social welfare while protecting the sensitive and fragile areas in the coastal counties and promoting sound development of coastal resources. Because Hilton Head Island is surrounded by waters over which the state has jurisdiction, it is fully subject to the provisions of the Coastal Management Act.

The Council operates through the efforts of an overall coastal zone management program and permitting process. The rules and regulations for the permitting process became effective May, 1978. A permit from the Coastal Council is required to alter a critical area. Tidelands, coastal waters, beaches, and dunes are declared to be critical areas. The rules and regulations specify the contents of the application for a permit, public notice and hearings, and decision criteria.

Typical projects on Hilton Head Island which require permits include piers, land and water transportation corridors, bridges, marinas, erosion control measures, and dredging or draining operations. Exceptions which do not require a permit include emergency repairs of public structures, recreation where permitted by law, research activities of public agencies or educational institutions, discharge of treated effluent as permitted by law, Corps of Engineers dredge and fill or collection and disposal of spoil operations, construction of boardwalks over dunes, and maintenance and repair of utilities, railroads, and piers.

In addition to permitting activities in critical areas, the Council also has powers of review and certification over activities in the coastal zone that will be conducted outside the critical areas. For example, the Coastal Council may review and certify treated effluent disposal permits, dredge and fill permits (Corps of Engineers), and construction and maintenance of a major utility certified in compliance with the South Carolina Utility Facility Siting and Environmental Protection Act of 1962, as amended in 1972. Public officials undertaking emergency actions to protect the public health and safety must notify the Council within 72 hours of their actions.

Procedures are established for appeals and enforcement. Definitions and boundaries of critical areas are described. A list of considerations for judging the costs and benefits of applications is included, as are design criteria.

Additional Policies Relating to Barrier Islands. The Coastal Management Act recognizes the fragile and dynamic nature of barrier islands and considers the following additional policies when reviewing permits for activities on barrier islands:

1. Construction and development on barrier islands shall retain to the extent feasible existing dune ridges, drainage patterns

and natural vegetation in landscaping and construction plans in order to maintain the value of the island as a storm buffer. Intensive or high density type development may not be suitable on some barrier islands which are less stable or more prone to erosion or other hazard risks; these factors must be taken into consideration when alternative development plans are formulated.

2. Because of their proximity to and strong ecological relationship with the critical areas of the coastal zone, project proposals for activities on barrier islands must demonstrate reasonable precautions to prevent or limit any direct negative impacts on the adjacent critical areas (beaches, primary dunes, coastal waters and wetlands).
3. New road or bridge projects involving the expenditure of public funds to provide access to previously undeveloped barrier islands will not be approved unless an overwhelming public interest can be demonstrated, for example, provision of access to a public recreation area or other facility. Preference will be given to ferry access in those instances where public funds cannot be expended for road access.
4. The extension of public services, such as sewer and water facilities, to barrier islands should only be proposed in a comprehensive approach which considers the natural "carrying

capacity" of the island to support development and which integrates these facilities to parallel the level of access which is available to the island.

5. The Coastal Council encourages and supports State, local and private efforts to acquire coastal barrier islands for inclusion in preservation and protection programs. Public recreational benefit should be one primary motivation for these efforts, and where appropriate, barrier islands should be maintained for recreational use, based on the capacity of individual areas to accommodate human activity.

Coastal Council Permit Process Analysis

The rules and regulations for the Coastal Council permit process were published in 1978. A series of applications for permits affecting development on Hilton Head Island have come before the Council. Most applications deal with routine matters such as private docks, replacement of culverts, and relocation of telephone cables. However, three proposals pending before the Council are controversial and their eventual outcome will set the tone for what environmentalists may expect from the Council in the future.

Closing the Folly. On May 22, 1979, the Coastal Council voted 6 - 5 to override its staff's recommendations and issue a conditional permit to the Broad Creek PSD to build a berm across the mouth of The Folly, a saltwater inlet north of Palmetto Dunes. Its waters would be re-routed into the Palmetto Dunes lagoon system and thence to Broad Creek. The purpose of the project, which has been under discussion for the past 20 years, is to reduce beach erosion.

A series of nine conditions were attached to the application providing for monitoring, review, restoration to natural conditions if significant environmental damages were documented, and the separation of The Folly's waters from the Palmetto Dunes' lagoon waters.

The Natural Resources Defense Council, The Sierra Club, and the S. C. Attorney General have appealed the permit. Objections have also been voiced by the U. S. Fish and Wildlife Service, the NAACP, and the Environmental Protection Agency. An evidentary hearing was held in late October, and the Council rejected the appeal on February 22, 1980. The permit application will now be submitted to the U. S. Corps of Engineers for approval.

Palmetto Dunes Marina. Palmetto Dunes Resort has applied to the Coastal Council for a permit to construct a marina on Broad Creek. Palmetto Dunes already has a permit issued by the Corps of Engineers prior to the existence of the Coastal Council. The new design proposed is less damaging to the environment. The Spanish Wells Property Owners Association and several individuals have notified the Coastal Council and Corps of Engineers of their objections to another marina on Broad Creek and have requested an environmental impact statement and public hearings. Nevertheless, on October 17 the Council approved the permit with conditions, and the formal appeals period has begun.

Harbour Town Marina. An ongoing problem is the silting up of the Harbour Town Marina harbor. The owners want a permit to use pneumatic dredging with disposal in Calibogue Sound, and the Council staff is working toward some sort of solution.

Summary

It is too early to judge the effectiveness of the Coastal Council's permitting process as a development control on Hilton Head Island. No clear cut trends have emerged yet from the Council's handling of a relatively small volume of permit applications.

FEDERAL CONTROLS

Federal laws and administrative acts which have implications for the provision of wastewater facilities on Hilton Head Island are summarized below.

- 1966 and 1973 Endangered Species Preservation Acts: Protects endangered species and the buying and selling of endangered flora. This act currently applies to 23 species of possible or known occurrence on Hilton Head Island. Detailed information concerning protected flora and fauna is presented in Chapter II-I of this report.
- 1969 National Environmental Policy Act: Requires consideration of the environmental impact of all federally funded projects. This act is the enabling legislation requiring the preparation of this study.
- 1970 Council on Environmental Quality: Establishes advisory body to the President.

- 1970 Clean Air Act: Establishes ambient air quality standards for federal government implementation.
- 1972 Water Pollution Control Act: Requires a permit program for liquid waste dischargers, sets water quality standards and goals for the nation. Amendments in 1977. Includes protection of wetlands in Section 404.
- 1972 Noise Control Act: Establishes noise emission standards.

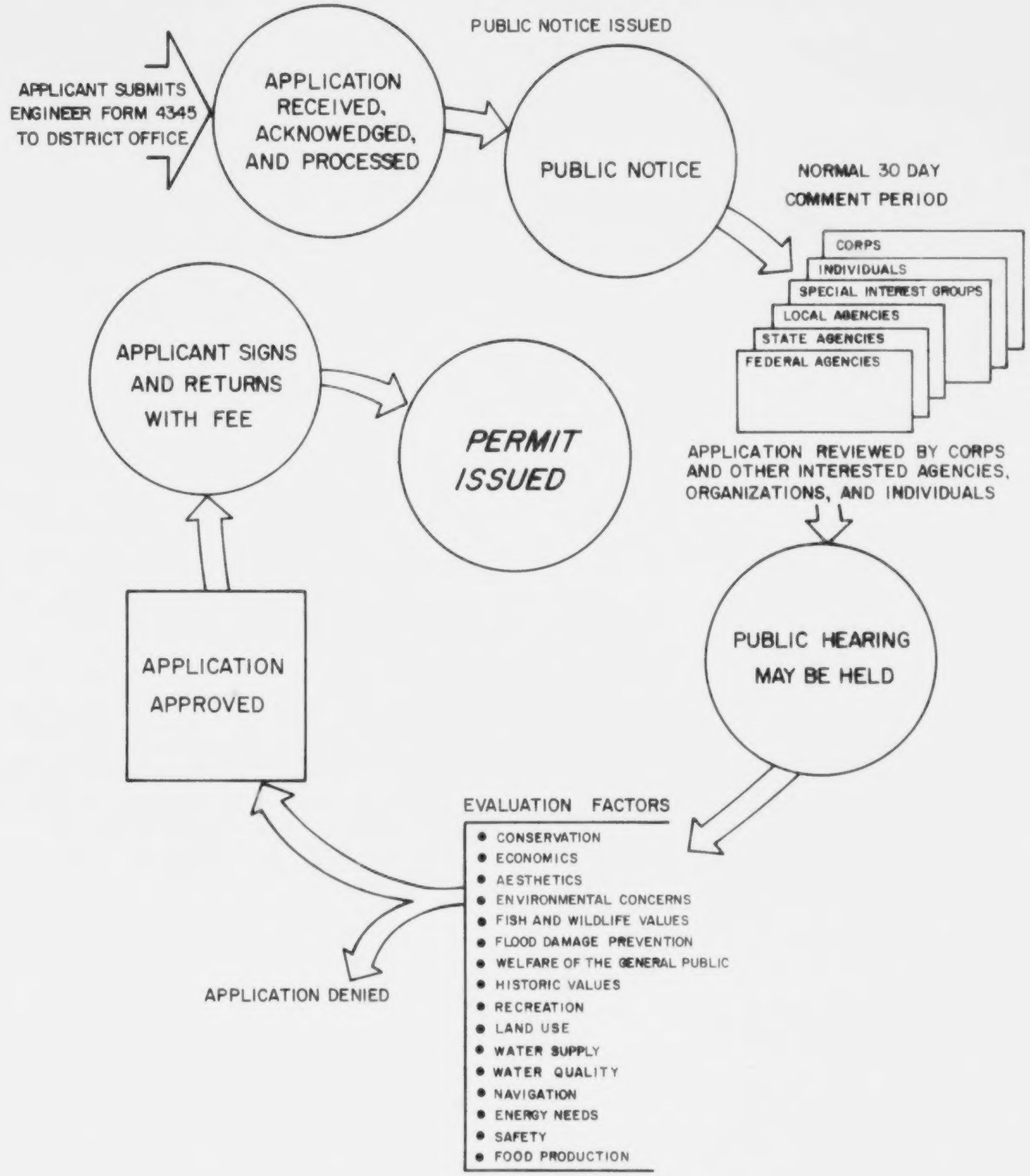
Section 404 Permit Process

Section 404 of the Water Pollution Control Act gives the Army Corps of Engineers (COE), in conjunction with EPA, the authority to regulate discharges of dredge and fill material into waters of the United States. Originally this jurisdiction applied only to navigable waters, but recent interpretations have extended regulatory powers to include all waters of the nation, including wetlands. Regulation of wetlands was initiated because of the high ecological value and vulnerability of these areas (see Chapter II-I for a more detailed discussion). Executive Order 11990 (42 Fed. Reg. 26961, 1977) has recently emphasized the importance of the Section 404 permit process by directing Federal agencies to place a high priority on the protection of wetland ecosystems.

Some typical activities requiring permits under Section 404 include: stone or earthen discharges, dredging, filling, artificial canals, artificial islands, dams, dikes, beach nourishment, groins, jetties, intake pipes, levees, mooring boys, ocean dumping, outfall pipes, piers, wharves, riprap, road fills, pipelines, and cables. Not all activities conducted in waters and wetlands require permit review, but the COE should be consulted before any alterations or developments in such areas are begun.

A summary of the COE Section 404 permit review process is shown in Figure III-D-1. Hilton Head Island is within the jurisdiction of the Charleston District of the COE; applications and/or questions concerning permits on the island are reviewed by this office. Detailed drawings and descriptions of proposed activities are often required before review can be completed. In the absence of objections, incomplete information, inaccuracies, etc., permits are usually issued within 60 to 90 days of application. Permit fees are $100 if proposed work is commercial in nature and $10 if non-commercial.

Under certain circumstances the COE finds that a proposed project will have an adverse impact on the public interests, and permit applications are denied. In such situations the applicant may consider the objections of the COE, modify the original project design, and re-submit the proposal for COE review. Such reconsiderations do not guarantee final COE approval, but provide an appeal process where sound design practices may be incorporated to eliminate the objectionable features of otherwise feasible projects. Permit-requiring work that is begun before COE authorization is given, or after application is denied, is a legally punishable offense. Violators may be subject to civil and/or criminal court action, fines of $500 to $50,000 per day, imprisonment for up to two years, and removal of structures and materials.


PUBLIC NOTICE ISSUED
APPLICANT SUBMITS ENGINEER FORM 4345 TO DISTRICT OFFICE
APPLICATION RECEIVED, ACKNOWEDGED, AND PROCESSED
PUBLIC NOTICE
NORMAL 30 DAY COMMENT PERIOD
CORPS
INDIVIDUALS
SPECIAL INTEREST GROUPS
LOCAL AGENCIES
STATE AGENCIES
FEDERAL AGENCIES
APPLICATION REVIEWED BY CORPS AND OTHER INTERESTED AGENCIES, ORGANIZATIONS, AND INDIVIDUALS
PUBLIC HEARING MAY BE HELD
EVALUATION FACTORS
• CONSERVATION
• ECONOMICS
• AESTHETICS
• ENVIRONMENTAL CONCERNS
• FISH AND WILDLIFE VALUES
• FLOOD DAMAGE PREVENTION
• WELFARE OF THE GENERAL PUBLIC
• HISTORIC VALUES
• RECREATION
• LAND USE
• WATER SUPPLY
• WATER QUALITY
• NAVIGATION
• ENERGY NEEDS
• SAFETY
• FOOD PRODUCTION
APPLICATION DENIED
APPLICATION APPROVED
APPLICANT SIGNS AND RETURNS WITH FEE
PERMIT ISSUED

SOURCE: U.S. ARMY CORPS OF ENGINEERS, 1977,
PERMIT PROGRAM: A GUIDE FOR
APPLICANTS. EP 1145-2-1.

TYPICAL CORPS PERMIT
REVIEW PROCESS

FIGURE III -D-1

Court decisions have upheld the power of the COE to deny permits for proposed developments on the basis of ecological considerations, as well as the more typical navigational reasons, providing that the ultimate public interest is concerned. A landmark case in Boca Ciega Bay, Florida where developers were denied permits to fill wetlands solely on the grounds of probable environmental damage established this precedent. In a similar case at Marco Island, Florida a development project involving the draining and filling of almost 3,000 acres of coastal wetlands for housing was prevented by the COE on the basis of negative environmental impacts.

With regard to development activities on Hilton Head Island, several 404 permit applications are presently under review by the COE. As previously mentioned, the proposal to close the Folly has recently been submitted to the COE for review. The controversial nature of this project may delay review procedures. Other permit applications currently being considered by the COE include an expansion plan for Palmetto Dunes Marina and the pneumatic dredging activity proposed for Harbour Town Marina.

CHAPTER III-E

ECONOMIC PROFILE

The economic profile of Hilton Head Island varies significantly from countywide averages. According to an analysis undertaken by the Hilton Head Chamber of Commerce, the island's resident population represents 14 percent of the Beaufort County population, produces 46 percent of the county's gross sales of goods and services, upon which the sales tax is based, and pays 56.0 percent of the county's property taxes. Annual payroll figures have risen from $18.5 million in 1972 to $66.5 million in 1978, a 259 percent increase. The details of each aspect of the island's economic profile are discussed below.

GROSS SALES OF GOODS AND SERVICES

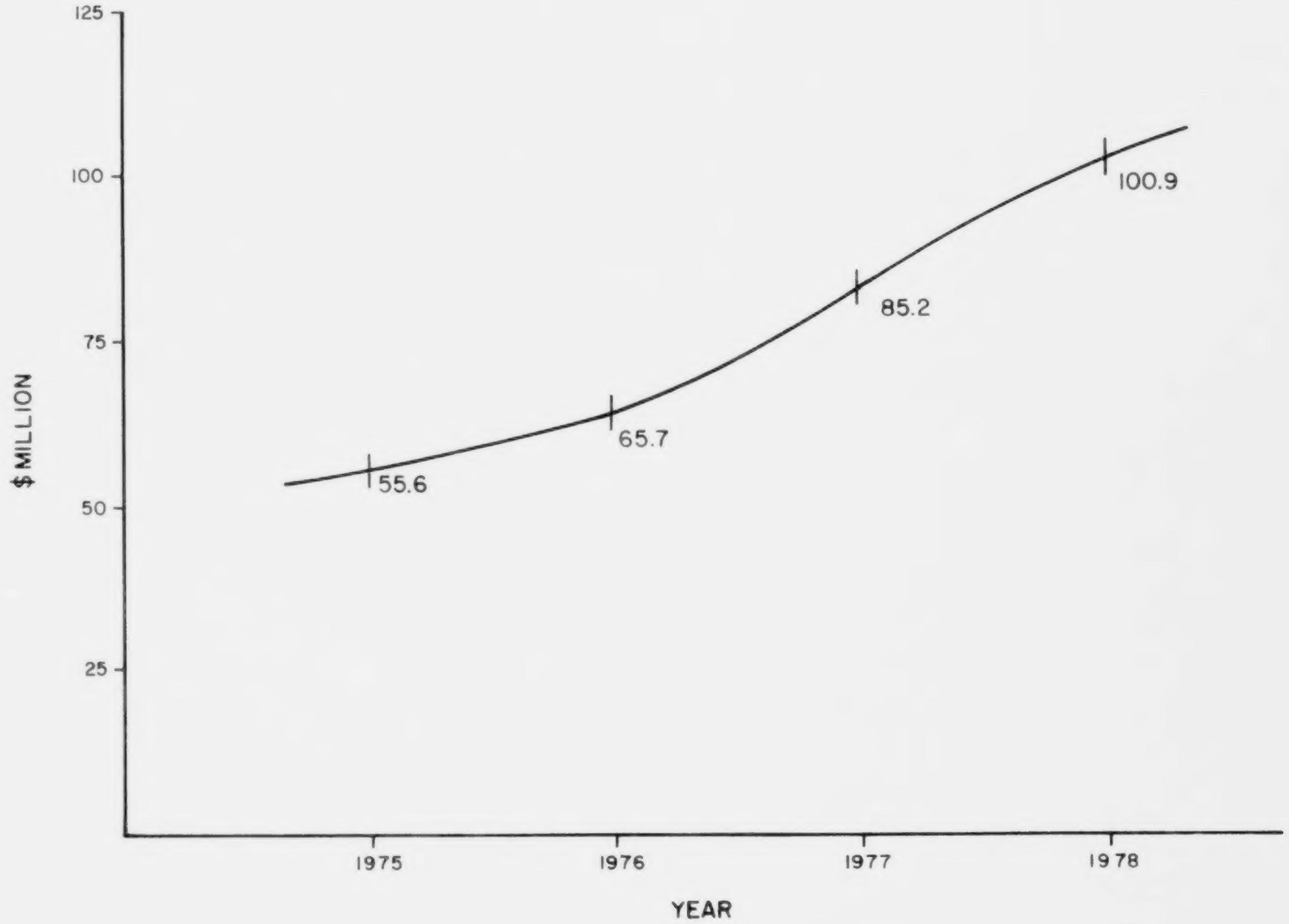
The South Carolina Tax Commission collects a tax on the sale of goods and services in the state and therefore has a record of gross sales for each year by counties and incorporated areas. The Tax Commission supplied the total gross sales for Beaufort County for the years 1975 through 1977. The figures for Hilton Head Island were not available because the island is not an incorporated area. However, the total gross sales for the 1975-1977 period for all firms with a Hilton Head Island address were provided. Any firm with headquarters located elsewhere in the state was not included. These are the only figures on gross sales of goods and services available for Hilton Head. Table III-E-1 and Figure III-E-1 present the available data.

TABLE III-E-1

GROSS SALES OF GOODS AND SERVICES

Year	Beaufort County	Hilton Head Island	% HHI of Beaufort
1975	$132,246,313	$55,561,048	42%
1976	$153,695,518	$65,701,861	43%
1977	$184,886,013	$85,208,407	46%

Source: South Carolina Tax Commission



GROSS SALES OF
GOODS AND SERVICES

III-E 2a

FIGURE III-E-

Gross sales in Beaufort County increased by 39% from 1975 through 1977, while gross sales on Hilton Head Island increased 53.4%. Gross sales in Beaufort County other than Hilton Head Island, increased 30.0% during this same period. Hilton Head Island accounted for 42% of the total gross sales in Beaufort County in 1975, 43% in 1976 and 46% in 1977. This trend is expected to continue.

Table III-E-2 gives a breakdown of gross sales in 1978 by commercial categories. Gross sales were higher than the previous year by 18.5 percent.

PROPERTY TAXES

Property tax revenues have increased in both Beaufort County and Hilton Head Island in recent years. Table III-E-3 summarizes property tax revenues for the county and Hilton Head during the period 1975 to 1979. Figure III-E-2 illustrates the rising trend of property tax revenues from Hilton Head.

In 1978, real estate subject to property taxes included land plus 3,440 single-family dwellings, 4,902 attached dwelling units (apartments, villas, etc.), four hotels/motels, plus commercial establishments. With the exception of a small ready-mix concrete operation, Hilton Head Island possesses no establishments which would be considered industrial enterprises.

TABLE III-E-2

GROSS RETAIL SALES OF GOODS AND SERVICES, HILTON HEAD ISLAND, 1978

Building Material, Hardware, Parts and Farm Equipment	$ 4,019,197
Department and General Merchandise Stores	4,295,942
Grocery and Related Products	8,603,877
Motor Vehicle, Boat and Airplane Dealers	2,583,330
Gasoline Stations, Auto Parts, Repair and Service	7,099,214
Apparel, Accessories and Jewelry	8,190,284
Home, Office and Store Furniture	1,420,334
Drug and Liquor Stores	5,016,042
Eating and Drinking Places	9,423,102
Sporting Goods	3,359,773
Household Appliances	1,797,301
Hotels, Motels - Lodging Places and Rental of Real Estate	15,727,919
Services	5,808,439
Other	23,583,971
TOTAL	$100,928,725

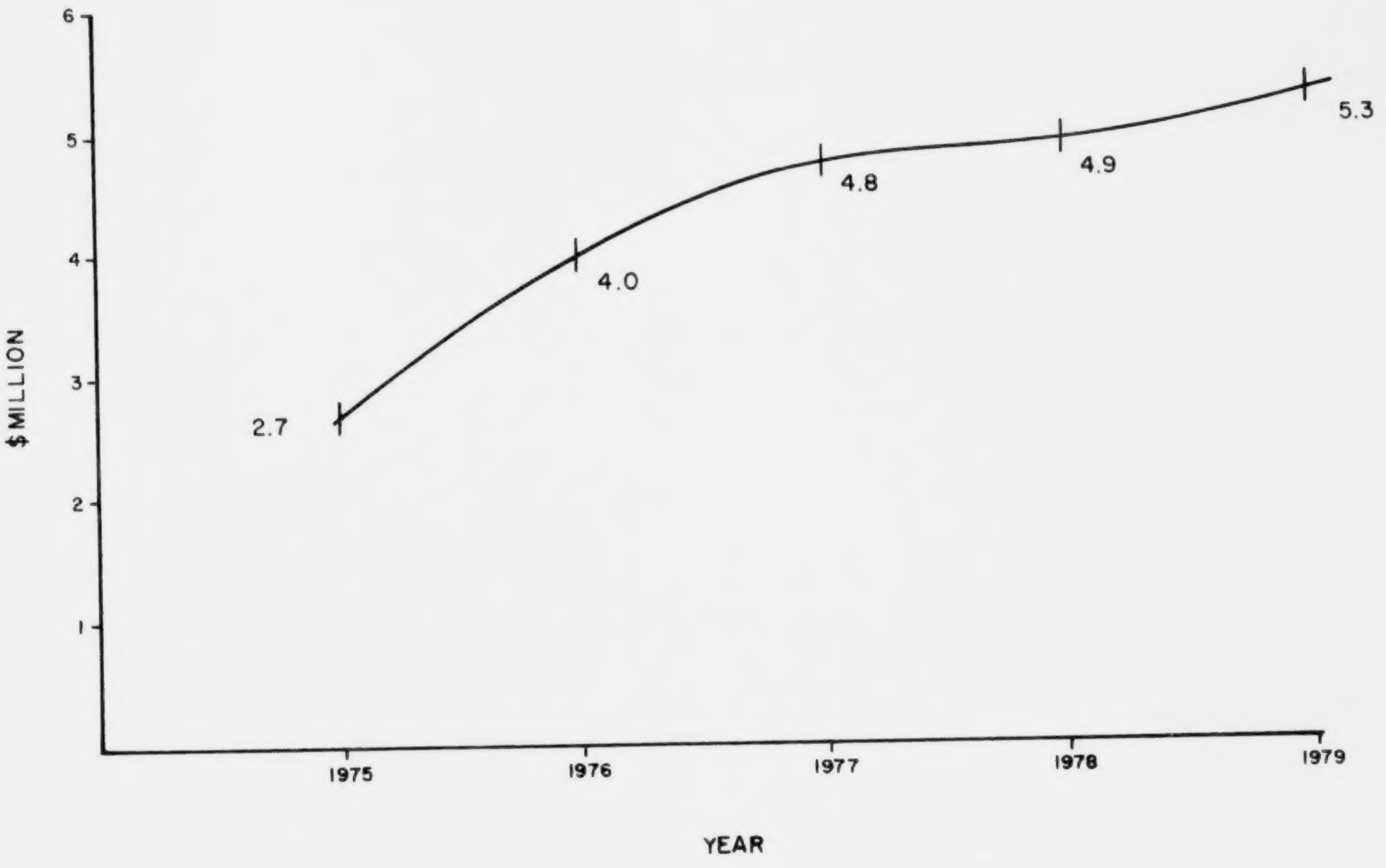
Source: Hilton Head Island Chamber of Commerce, 1979

TABLE III-E-3

PROPERTY TAX REVENUES

Year	Beaufort County	Hilton Head Island	% HHI of Total County
1975	$5,117,423	$2,731,383	53.4%
1976	$7,319,542	$4,027,489	55.0%
1977	$8,788,866	$4,838,847	55.1%
1978	$9,204,929	$4,904,411	53.3%
1979	$9,839,179	$5,347,894	54.4%

Source: Hilton Head Island Chamber of Commerce, 1978 and Beaufort County Treasurer's Office, 1979.



PROPERTY TAX REVENUES

FIGURE II

EMPLOYMENT AND PAYROLLS

The Hilton Head Island Business Survey, 1978 published by the Chamber of Commerce describes employment characteristics by seven major business groups and estimates annual payrolls. Table III-E-4 shows base and seasonal employment by business group.

Resort and restaurant, construction, and services account for the greatest number of employees both as a base and as a maximum. The percent of seasonal increase also follows the same sequence.

Table III-E-5 shows the average number of employees per business group, by sex, by work status, and geographic origin.

In 1978, 598 businesses on Hilton Head employed an average of 7,540 persons on a year-round basis. Two-thirds of these businesses (66.2%) were retail, wholesale, or service businesses; however, they accounted for less than a third (29.7%) of the employment. Resort and restaurant operations represent only 10.4 percent of the businesses, but they employ the most employees (almost 40 percent of the total employees). This can be attributed to the number of operations within the plantations and resorts that are included under a single business and one payroll.

The average annual payroll per employee in 1978 was $8,829, which was not significantly larger than the 1976 average of $8,701. Several business groups had averages greater than $10,000 per annum. The

TABLE III-E-4

BASE AND SEASONAL EMPLOYMENT, 1978

Type of Business	Employment Minimum	Employment Maximum	Net Difference	Seasonal % Increase
Resort and Restaurant	2,745	3,259	+ 514	18.7
Construction	1,311	1,467	+ 156	11.9
Services	1,102	1,213	+ 111	10.1
Retail and Wholesale	1,048	1,117	+ 69	6.6
Trans., Comm. and Util.	363	384	+ 21	5.8
Fin., Ins. and Real Est.	330	334	+ 4	1.2
Schools and Govt.	202	202	+ 0	0.0
TOTALS:	7,101	7,979	+ 878	

Source: Hilton Head Island Chamber of Commerce. Hilton Head Island Business Survey, 1978. August 1979.

TABLE III-E-5

EMPLOYMENT BY WORK STATUS, SEX, AND GEOGRAPHIC ORIGIN

Type of Business	Busn.	Emp.	Full-Time	Part-Time	Male	Female	On Isl.	Off Isl.
Resort and Restaurant	62	3,002	2,599	403	1,530	1,472	1,575	1,427
Construction	55	1,389	1,334	55	1,292	97	573	816
Services	200	1,157	993	164	669	488	747	410
Retail and Wholesale	196	1,083	776	307	593	490	721	362
Trans.,Comm. and Util.	26	373	345	28	258	115	204	169
Fin.,Ins., and Real Est.	40	334	302	32	150	184	298	36
Schools and Govt.	19	202	174	28	88	114	165	37
TOTALS:	598	7,540	6,523	1,017	4,580	2,960	4,283	3,257
			(87%)	(13%)	(61%)	(39%)	(57%)	(43%)

Source: Hilton Head Island Chamber of Commerce. Hilton Head Island Business Survey, 1978. August 1979.

highest average annual payroll continued to be in finance, insurance, and real estate firms with an annual average of $14,375. This was followed by transportation, communications, and utilities with $12,115 and services with $10,519. The higher incomes of services were associated with the professional services (with an average of $12,728). Table III-E-6 gives a detailed breakdown of payroll data.

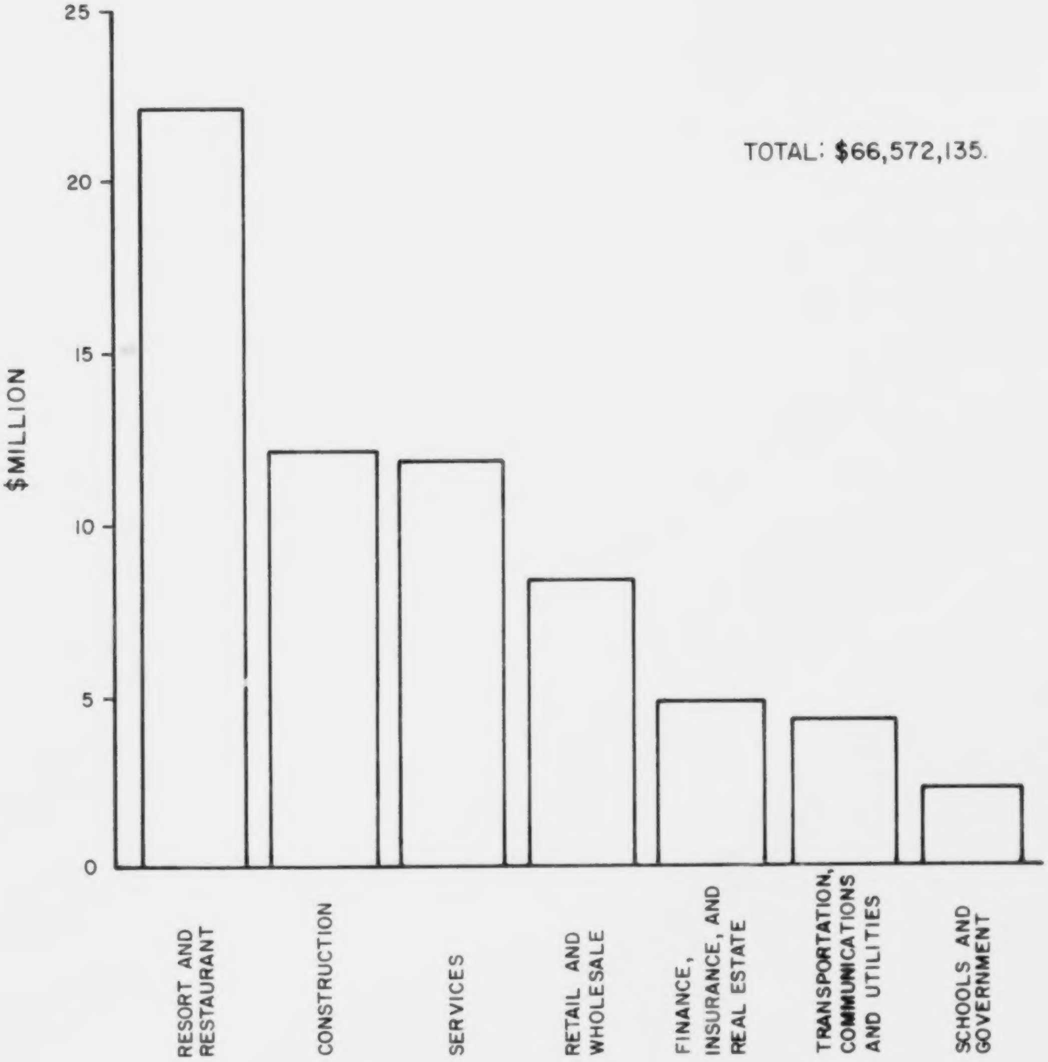
Figure III-E-3 shows graphically the major dependence of islanders on the resort and restaurant sector. This payroll is almost twice that of construction or services and, by itself, represents one-third of the total island payroll.

TABLE III-E-6

AMOUNT AND PERCENT OF ANNUAL PAYROLL AND AVERAGE ANNUAL PAYROLL PER EMPLOYEE

Type of Business	Annual Payroll	% of Total Payroll	Average Annual Payroll
Resort and Restaurant	$22,417,211	33.7	$ 7,467
Construction	$12,297,826	18.5	$ 8,854
Services	$12,170,314	18.3	$10,519
Professional	(4,785,882)	(7.2)	(12,728)
Other	(7,384,432)	(11.1)	(9,455)
Retail and Wholesale	$ 8,506,813	12.8	$ 7,855
Trans., Comm. and Util.	$ 4,530,831	6.8	$12,115
Fin., Ins. and Real Est.	$ 4,801,179	7.2	$14,375
Schools and Govt.	$ 1,847,961	2.7	$ 9,148
TOTALS:	$66,572,135	100.0%	$ 8,829

Source: Hilton Head Island Chamber of Commerce. Hilton Head Island Business Survey, 1978. August 1979.



ANNUAL PAYROLL
PER BUSINESS SECTOR, 1979

FIGURE III-E-3

CHAPTER III-F

THE COMMERCIAL FISHERIES IN THE HILTON HEAD AREA

This chapter presents preliminary information on the commercial fishing industry of the Hilton Head area. In most cases the Hilton Head area is considered to be Calibogue Sound and its tributaries. Shrimp fishing and charter boat fishing by their nature cover Calibogue Sound, Port Royal Sound and the open ocean waters. Shrimp fishing statistics in open waters are restricted to the area lying directly off-shore from Hilton Head Island. Charter boat fishing covers trips that originate on Hilton Head Island but may extend to as much as 80 nautical miles off-shore to the Gulf Stream. Other industries include commercial oyster, crab and clam fisheries. Major distributors and processors of these fisheries were interviewed to obtain information on catch statistics and dollar values to local residents. No attempt was made to extrapolate this to the retail market, nor was an attempt made to estimate the quantities or values of the various fisheries that may be harvested illegally, harvested for sport, harvested for subsistence living or landed by out-of-state vessels.

Most of the information presented in this chapter was obtained from personal interviews in a period of 1-1/2 weeks in October-November 1979. Some information was obtained via telephone conversations. The detail of statistical information between and within the various fisheries varies significantly. In some cases individuals opened up their records for review. In other instances approximations were given of the fish harvests.

Based upon 1978 landings, the value of the commercial fisheries to the Hilton Head area is around three million dollars a year, exclusive of the retail market (Table III-F-1, Figures III-F-1 and III-F-2). This value of the fishery is considered to be a minimal estimate. In many instances the economical yield and maximum sustained yield of the local fishery is many times less than what it could be. Oysters are being under-exploited due to a lack of hand labor to pick and shuck oysters. Clams are under-exploited due to a lack of hand labor and a local market. Because of cold winters, shrimp harvests over the last two years have been nearly half of what they have typically been in the past. Shrimp harvests for 1979 are expected to return to 1976 levels because of an extremely good white shrimp season.

The cultural and sociological significances of the local fishery should also be considered. Most of the people employed by the seafood industry around Hilton Head are low income, often poverty level blacks (Figure III-F-3). Loss or degeneration of any of the fisheries could have a major impact on the local black community, as well as a number of white families, both of whose fishing heritages have been passed down from generation to generation. Loss of the non-renewable fishery resources would not only mean an economic loss but the displacement of a people whose way of life and history can not be valued in monetary terms. An

TABLE III-F-1

VALUE OF THE COMMERCIAL FISHERIES TO THE HILTON HEAD AREA, (CALIBOGUE SOUND, PORT ROYAL SOUND, AND IN THE OCEAN OFF HILTON HEAD ISLAND), 1978

Fishery	Pounds	US Bushels	Gross Value Dollars	Percent of Total	Number of People Employed	Dollars Paid To Employees	Gross Income to Lease (6) Holder or Industry Before Expenses Taken Out (Dollars)
Shrimp	510,905	NA	$ 1,691,096	56	137 Persons	$ 563,699	$1,127,397
Oyster (1)	NA	279,661	459,287	15	Up to 140 Persons	222,541	236,746
Crabs	685,177	12,809	267,307	9	Up to 50 Persons	184,875	82,432
Clams	125,720	1,676	82,137	3	17 Persons	58,669	23,468
Charter Boat Fishing (2)	NA (4)	NA (4)	500,000	17	Up to 40 Persons	- (5)	- (5)
Total	NA (4)	NA (4)	$ 2,999,827	100	Up to 384 Persons	$1,029,784	$1,470,043

(1) Oyster Season From September 1978 Through June 1979.

(2) The Value of Sportfish estimated Based Upon 1979 Statistics Obtained in Survey.

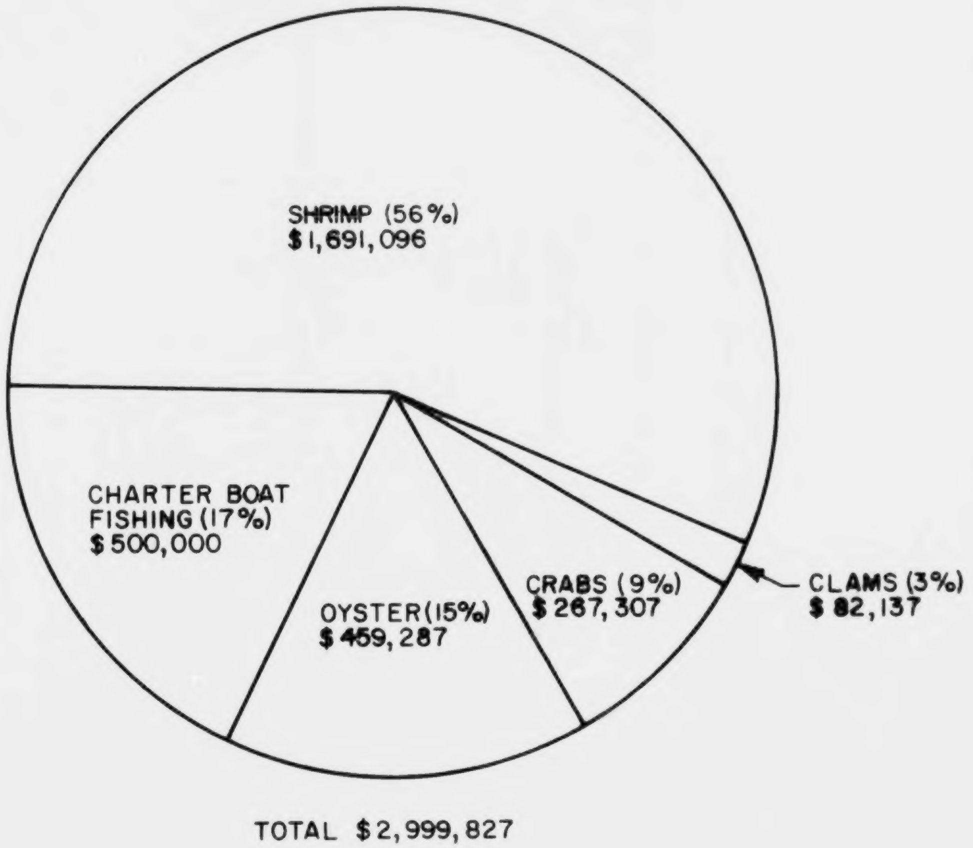
(3) The Above Information Based Upon Interviews With the Following Organizations:

- (a) Shrimp Distributors: H. H. Von Harten and Sons, Hilton Head Fish Cooperative, Hilton Head Seafood Company, Hudson's Sea Food, Sea Island Sea Food Corporation.
- (b) Oyster Distributors: Hudson's Sea Food, Bluffton Oyster Cooperative, Hilton Head Oyster Company, Billy Toomer, Hilton Head Seafood, Andrew Kidd III, Thad Bailey.
- (c) Major Crab Distributors: Lemon Island Marina, Drawdy's Seafood, Hudson's Seafood, Hilton Head Seafood.
- (d) Major Distributors of Clams: Coastal Sea Food, Lemon Island Marina, Hudson's Seafood, Drawdy's Seafood.
- (e) Dick O'Neill of Harbor Town Marina, Charter Boat Captains Joe Buckles, Miles Altman and Fuzzy Davis Interviewed to Obtain Information.

(4) **NA = Not applicable.**

(5) **Information not available.**

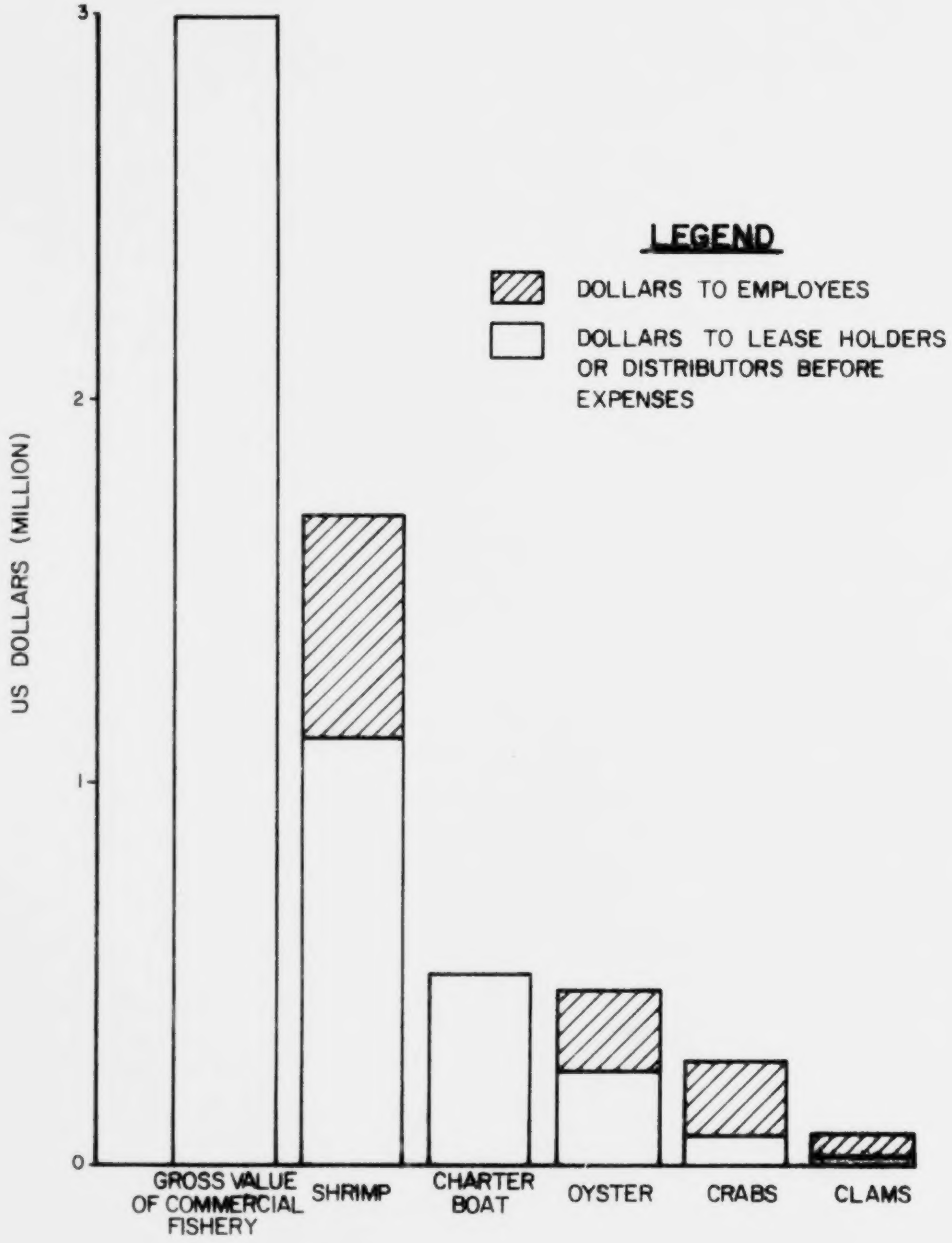
(6) **Dollars paid to employees already subtracted.**



VALUE OF THE
COMMERCIAL FISHERIES
TO THE HILTON HEAD AREA

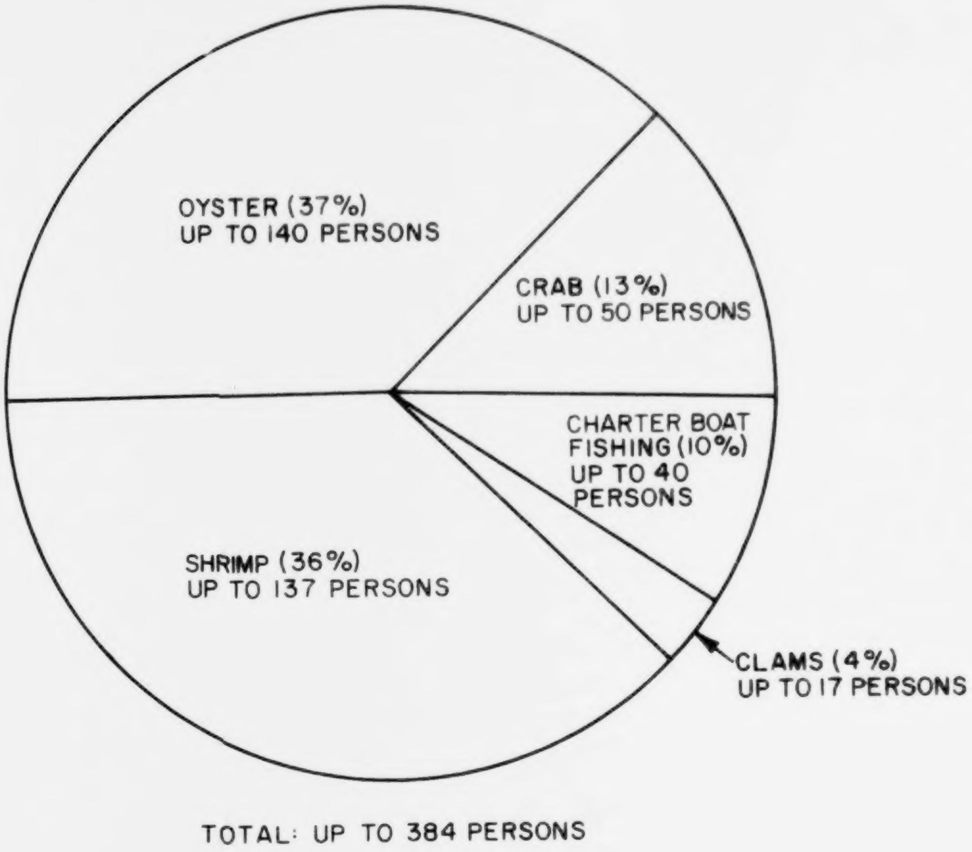
HH·F 5a

FIGU



DISTRIBUTION OF DOLLARS FROM THE COMMERCIAL FISHERY AROUND HILTON HEAD ISLAND. BASED UPON 1978 STATISTICS

FIGURE III - F - 2



EMPLOYMENT BY THE COMMERCIAL FISHERIES IN THE HILTON HEAD AREA

FIGURE III-F-3

additional philosophical approach that must be considered is the value of the fishery to the island developers and to the tourist trade. People have been attracted to Hilton Head because of its mild climate, pristine waters, excellent sportfishing and the superb cuisine of the local seafood restaurants. Degeneration of the fishery by pollution of local waters could consequently adversely impact much of Hilton Head's appeal.

The following sections describe the various fisheries and provide a more thorough breakdown of their value to the Hilton Head area.

COMMERCIAL SHRIMP FISHERY

Landings from the shrimp fishery off Hilton Head Island and the State of South Carolina consist of the brown shrimp, (*Penaeus aztecus*) and the white shrimp, *Penaeus setiferus*). Both the brown and white shrimp breed off-shore using the marshes and creeks of Calibogue Sound and its tributaries as a nursery ground. The brown shrimp fishery opens in June of each year. By law, bottom trawling for brown shrimp requires that boats remain at least one-quarter mile off-shore while fishing from Hilton Head Island. Usually the catches of brown shrimp per-unit-of-effort begin falling off by early August. The brown shrimp season terminates in September. Sometime in September, depending on the size of shrimp showing up in experimental trawls, the State of South Carolina opens up Calibogue and Port Royal Sounds, as well as the near-shore areas off the beaches of Hilton Head Island, for the capture of white shrimp.

Based upon the only monthly records obtained from this survey, brown shrimp accounted for 23% of the total catch if landings for June, July and August are compared against total landings for the 1978 season as recorded by the Hilton Head Fishing Cooperative (Table III-F-2). White shrimp accounted for 77% of the total shrimp landed by the Cooperative for 1978. Mr. Frank Sanders of the Hilton Head Fishing Cooperative explained that during a typical year the brown shrimp account for 35% of the landings and the white shrimp for 65% of the landings. The cold winters of 1977 and 1978 dropped water temperatures in the estuaries to the low 40's (F). This resulted in decreased spring roe shrimp populations and thus decreased summer brown shrimp and fall white shrimp landings. The last substantial shrimp landings around the Hilton Head area were in 1976 (Table III-F-3). Projections are that the 1979 season should be a good year equal to the 1976 season. While 1979 brown shrimp landings were low, white shrimp are being harvested in near record quantities.

An attempt was made to obtain yearly landings from the five major shrimp wholesalers which fish off of the Hilton Head area (Table III-F-4). This includes Calibogue and Port Royal Sounds, as well as in the near-shore waters off the ocean side of Hilton Head Island. The catch statistics provided by the five major distributors represent only those poundages landed off the Hilton Head area. The only complete year obtainable was 1978 which produced 510,905 pounds of heads-off shrimp valued at an ex-vessel price (money paid to the boat and crew before expenses) of 1,691,096 dollars (Table III-F-5). With an increased average weighted

TABLE III-F-2
MONTHLY SHRIMP LANDINGS DURING THE 1978 SEASON OF THE HILTON HEAD FISHING COOPERATIVE, HILTON HEAD, SOUTH CAROLINA

Month	Quantity Landed	Average Weighted Ex-Vessel Price Per Pound of Heads-Off Shrimp (1)
June	3,329	$2.32
July	14,246	$2.60
August	9,974	$3.08
September	26,641	$3.40
October	39,326	$3.44
November	19,868	$3.63
December	8,181	$3.50
Season's End	121,565	$3.31

(1) Average Weighted Ex-Vessel Price. This is the average price paid per pound of shrimp as it comes off the boat. Prices per pound vary by the size of the shrimp, time of year and from year to year. An average weighted monthly and then a yearly ex-vessel price was determined for 1978.

(2) Reference: Bruce Epler of the Southern Cooperative Development Fund.

TABLE III-F-3

SHRIMP PRODUCTION AND AVERAGE WEIGHTED EX-VESSEL PRICES OF THE HILTON HEAD FISHING COOPERATIVE, HILTON HEAD, SOUTH CAROLINA

Year	Pounds Landed	Average Weighted Ex-Vessel Price Per Pound of Heads-Off Shrimp (1)
1969	225,000	$1.11
1970	150,000	$ .92
1971	195,000	$1.22
1972	190,000	$1.21
1973	275,000	$1.63
1974	175,000	$1.12
1975	191,500	$2.02
1976	238,000	$2.35
1977	71,373	$1.75
1978	121,565	$3.31
1979	240,000(2)	$4.00

(1) Average Weighted Ex-Vessel Price. This is the average price paid per pound of shrimp as it comes off the boat. Prices per pound vary by the size of the shrimp, time of year and from year to year. Average yearly weighted ex-vessel prices are presented above.

(2) Projections by Frank Sanders of The Hilton Head Fishing Cooperative.

(3) Reference: Bruce Epler of The Southern Cooperative Development Fund and Frank Sanders, Hilton Head Fishing Cooperative.

TABLE III-F-4

SHRIMP PRODUCTION IN THE HILTON HEAD AREA, (CALIBOGUE SOUND, PORT ROYAL SOUND AND IN THE OCEAN OFF HILTON HEAD ISLAND)

Shrimp Company	Number of Boats/Fishermen	Pounds Of Shrimp (Heads-off) 1979	1978	1977	1976
1	11/30	__(1)	121,565	71,373	238,000
2	3/9	__(1)	30,000	__(1)	__(1)
3	1/3	__(1)	33,600	__(1)	__(1)
4	16/35	500,000(2)	220,000	180,000	460,000
5	25/60	119,272(3)	105,740	157,143	__(1)
Total	56/137	619,272	510,905	408,516	698,000

(1) Information not provided.
(2) Projected, based upon 1979 catch from June - November 1979.
(3) Actual catch from June - November 1979.
(4) Major shrimp companies interviewed: H. H. Von Harten and Sons, Hilton Head Fish Cooperative, Hilton Head Seafood, Hudson's Seafood, Sea Island Seafood Corporation. Order of names does not necessarily correspond to the order of above numbers.

TABLE III-F-5
EX-VESSEL VALUE OF SHRIMP PRODUCTION IN THE HILTON HEAD AREA, (CALIBOGUE SOUND, PORT ROYAL SOUND AND IN THE OCEAN OFF HILTON HEAD ISLAND), JUNE 1978 - DECEMBER 1978

Shrimp Company	Pounds of Shrimp (Heads-off)	Value (1) (Dollars)	Dollars to (2) Boat	Dollars to (3) Crew
1	121,565	$ 402,380	$ 268,253	$134,127
2	30,000	99,300	66,200	33,100
3	33,600	111,216	74,144	37,072
4	220,000	728,200	485,467	242,733
5	105,740	350,000	233,333	116,667
Total	510,905	$1,691,096	$1,127,397	$563,699

1) Weighted Average Ex-vessel Price of $3.31 Per Pound.
2) 2/3 of Ex-vessel Value to Boat/Boat Owner Before Expenses (Personal Communication Eugene Orage, Shrimp Boat Captain and Owner, Hilton Head Fishing Cooperative).
3) 1/3 of Ex-Vessel Price Paid to Crew Before Expenses (Personal Communication Eugene Orage, Shrimp Boat Captain and Owner, Hilton Head Fishing Cooperative).
4) Major Shrimp Companies Interviewed: H. H. Von Harten and Sons, Hilton Head Fish Cooperative, Hilton Head Fish Company, Hudson's Seafood, Sea Island Seafood Corporation. Order of Names Does Not Necessarily Correspond to the Order of Above Numbers.

ex-vessel price projected at 4.00 dollars or more per pound and a return to landings equalling 1976 levels, this dollar figure could more than double for the 1979 season.

Besides these five major distributors, approximately 58 smaller commercial boats, (15-30 feet long), are licensed by South Carolina and fish in the Hilton Head area. Additionally, a number of out-of-state trawlers from North Carolina and Georgia fish these waters. As an example, Ambrouse Sea Food of Thunderbolt, Georgia is known to have two boats which trawl for shrimp off the Hilton Head area. Quality Seafood of Savannah, Georgia has one boat that fishes off this area. Landings from these groups could not be quantified but are believed to be substantial.

Approximately 137 fishermen work for the major distributors, and earn a portion of their living from fishing off Hilton Head Island. It was not possible to determine the unit-of-effort or man hours fished by these boats around Hilton Head versus other areas of South Carolina.

The majority of the shrimp landed from the Hilton Head Area are iced and sold to wholesalers who truck the shrimp to breading factories in Brunswick, Georgia, and Tampa and Key West, Florida. Here the shrimp are breaded and packaged for sale in supermarkets. The local distributors receive an average mark-up of 27 cents per pound over the ex-vessel price.

OYSTER FISHERY

A survey of the oyster industry was conducted in November 1979. As part of the survey the major lease holders, distributors and processors of oysters in the Hilton Head area were interviewed. A detailed interview was held with Mr. Gilbert Maggioni whose family has been in the oyster processing business since the early 1880's. Mr. Maggioni presently owns and operates the Ocean, Lake and River Fish Company which is the major processor of canned oysters in South Carolina. Mr. Maggioni has lived and worked through the changes which have taken place in the industry. The following information is based upon a conversation held with Mr. Maggioni and other lease holders. This information is supported by the literature and has been accepted in discussions with State shellfish experts.

In the early days of the oyster industry in South Carolina oyster beds extended many miles inland. Extensive subtidal and intertidal beds of the oyster (_Crassostrea virginica_) were harvested. The change in oyster populations can be tied to changes in land use of the South Atlantic Coastal Plain. Prior to 1935 the Coastal Plain was dominated by small farms, small scale logging, and turpentine production. With the depression and low land values of the 1930's large tracts of land were purchased for as little as 2 dollars an acre by large logging concerns and corporate farms. This change in land use coincided with the development of the Kraft process. which used sulfate to break down wood fibers in yellow pine to make paper. Swamps were drained and the large tracts of pines were planted in their place. It is estimated by Mr. Maggioni that Union Camp alone has 84 million acres while International Paper has 125 million acres of timber lands on the Coastal Plain.

These changes in land use had a major impact on water quality. The deciduous forests, swamps and small scale farms provided an abundance of ground cover or traps which allowed water to gradually percolate and infiltrate into the groundwater aquifer and eventually into the coastal estuaries. As a result, salinities in the upper estuary tended to remain low and somewhat constant on a year round basis providing an excellent habitat for subtidal oyster populations.

The change over in land use to large tracts of pine forests and corporate farms resulted in a situation where run-off increased because of reduced infiltration. This meant a rapid loss of fresh waters into the estuaries after each rainfall causing rapid fluctuations in salinity and increased siltation. At the same time channelization projects by the U.S. Army Corps of Engineers resulted in increased saltwater intrusion into the upper estuaries.

These changes in the salinity regime and increased sedimentation resulted in a loss of the subtidal oyster fishery which was adapted to a low and relatively constant salinity regime. Increased siltation inhibited the functioning of the oysters' filter feeding and respiratory mechanisms. It also produced a less than ideal bottom for the settling and growth of oyster spat. By 1940 these changes had significantly reduced the subtidal oyster fishery as a commercially exploitable natural resource. Today only the Wando River near Charleston Harbor has a significant subtidal oyster fishery and it is in a degraded state.

Continued changes in land use on the Coastal Plan have resulted in the pollution and closure of many oyster beds for public health reasons. This has occurred recently in a portion of the oyster beds located along Broad Creek, Hilton Head Island. Approximately one-fourth of the Hilton Head Oyster Company's lease is presently closed to oyster harvesting.

Today the oyster fishery of South Carolina is intertidal and is restricted to the backside of barrier islands and about two miles inland along the coastal estuary. Intertidal oysters are adapted to high saline conditions. On a long term basis, environmental deterioration of the oyster beds and closure for public health reasons have the potential to further restrict the areas exploitable for oyster production.

Oyster beds are state owned and leased to private individuals for commercial purposes. In turn lease holders must maintain their beds by replanting the oyster grounds with shells to allow surfaces for oyster spat to settle upon and develop. Today the major commercial leases around the Hilton Head area, Calibogue Sound and its tributaries, total over 1400 acres (Table III-F-6). Additionally the Bull Creek side and a portion of the May River side of Bull Island, as well as Last End Point on Pinckney Island along Mackay Creek have been set aside as public oyster grounds for sport picking.

TABLE III-F-6
MAJOR OYSTER LEASES IN THE HILTON HEAD AREA, (CALIBOGUE SOUND AND ITS TRIBUTARIES)

Lease Holder	Area Around Hilton Head Island	Acres Under Lease
Hudsons Seafood Co.	Skull Creek	61
Hilton Head Oyster Co.	Broad Creek	127
Hilton Head Co.	-	2
S. V. Toomer	Jarvis Creek	459
Bluffton Oyster Coop.	May River	364
Skull Creek Oyster Coop.	Skull Creek	12
Hilton Head Seafood	Skull Creek	97
Thomas C. Barnwell, Jr.	Skull Creek	1
Mrs. O. T. McIntosh	Bram Point	1.3
Thad Bailey	Colleton River	310
TOTAL...		1,434.3

References: a) Steve Hopkins, Regional Biologist, South Carolina Wildlife and Marine Resources Department

b) Personal Communication with Lease Holders

In addition to changes in land use, the availability of labor has also had a major impact on commercial oyster production. Unlike most fisheries, the oyster production around Hilton Head and throughout most of South Carolina is low because of under-exploitation rather than over-exploitation. Since about 1945, governmental, social, economic and welfare policies have contributed to a decline in hand labor necessary to harvest the intertidal beds. Development of Hilton Head Island as a resort center has provided regular better paying work in service institutions such as restaurants and hotels to the up and coming work force that previously had been cycled into the oyster industry. These jobs provide regular hours, generally higher wages and are less physical in nature.

The typical oysterman in the Hilton Head area is black and averages 50 years in age. He is not being rapidly replaced in the oyster industry by his sons or daughters. Many people believe that major changes in the management of the oyster industry, as well as changes in harvesting techniques will be required if this industry of South Carolina is to survive the next decade. Some people have considered bringing in outside labor such as the Vietnamese who are being brought into the United States as political refugees. The Bluffton Oyster Cooperative presently has two Vietnamese employed as oyster pickers, (Personal Communication, Andrew Kidd III and Bruce Epler). Other people feel that a functional, mechanical harvester needs to be developed to make the industry less labor intensive. Another suggestion presented is that a gradual change from private leases to more State managed leases should occur. The State could employ mechanical harvesters to transplant polluted oysters to open public grounds. Licensed commercial oystermen would then be free to harvest on all public grounds. By opening up the oyster industry, more individuals could perhaps be drawn into the industry.

Oyster Production Around Hilton Head

Based upon personal interviews with the major lease holders and individuals involved in the distribution and processing of oysters, an estimated 279,661 U. S. bushels of oysters valued at approximately 459,287 U.S. Dollars were harvested around Hilton Head area during the 1978-79 season (Calibogue Sound and its tributaries), (Table III-F-7).

As determined by this survey, the oyster industry employs up to 141 pickers and shuckers predominantly from the black community in the Hilton Head area. A similar survey conducted by the regional State fishery biologist indicates many more persons being employed (Table III-F-8). The difference may be explained by the nature of the jobs. Most jobs in the oyster business are temporary and seasonal in nature. The numbers of pickers and shuckers available to harvest oysters vary from day to day making it difficult to accurately evaluate the actual number of persons employed.

Oyster Processing in the Hilton Head Area

The processing and value of oyster harvests may be delineated

TABLE III-F-7
OYSTER PRODUCTION IN THE HILTON HEAD AREA, (CALIBOGUE SOUND AND ITS TRIBUTARIES), SEPTEMBER 1978 - JUNE 1979.

Major Oyster Distributors	Number of Persons Employed	Raw Shucked Oysters(1) (US Bushels/Value $'s)	Trucked or Cluster Oysters(2) (US Bushels/Value $'s)	Selects: Singles or Roasters(3) (US Bushels/Value $'s)	Total (US Bushels/Dollars)
1	17 Pickers 25 Shuckers	15,621/100,651	36,987/27,398	745/ 8,605	54,353/136,654
2	15 Pickers 10-25 Shuckers	10,971/70,590	49,484/36,655	-(4)	60,455/107,345
3	12-14 Pickers 3 Shuckers	960/ 6,186	20,979/15,540	-(4)	21,939/21,726
4	3 Pickers 6 Shuckers	3,072/19,794	-(4)	-(4)	3,072/19,794
5	1 Picker	-(4)	14,175/10,500	1,700/19,635	15,875/30,135
6	10-12 Pickers	-(4)	51,030/37,800	-(4)	15,030/37,800
7	5 Pickers	-(4)	66,150/49,000	-(4)	66,150/49,000
8	12-15 Pickers and Shuckers	6,483/41,772	-(4)	1,304/15,061	7,787/56,833
TOTAL...	Up to 141 Persons	37,107/239,093	238,805/176,893	3,749/43,301	279,661/459,287 (Grand Total)

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(1) a) Three US Bushels per gallon of oysters
b) 21 US Dollars per gallon, 1978-79 retailed by local oyster house to individuals. Very small percentage of total oysters marketed.
c) $18.50 US Dollars per gallon, 1978-79, wholesale
d) Use average value of **$19.33 per gallon, value not weighted since level of information not available from most lease holders**

(2) a) Trucked to Ocean Lake and **River Fish Company, Lady's Island, S.C.**
b) Data provided as SC bushel. (SC bushels) x 1.89 = US bushels.
c) Lease holder paid $1.40 dollars/SC bushel, wholesale value.

(3) Weighted average **$11.55/bushel, wholesale/retail**

(4) Insignificant or nothing

(5) Major oyster distributors: Hudson's Sea Food, Bluffton Oyster Cooperative, Hilton Head Oyster Company, Billy Toomer, S.V. (Chief) Toomer, Hilton Head Sea Food, Andrew Kidd III, Thad Bailey. Order of names does not correspond to numbers above.

TABLE III-F-8

LABOR FORCE AND EARNINGS
HILTON HEAD ISLAND AREA
OYSTER AND CLAM FISHERY

Lease Holder	Employment From Oyster Leases
lease #1	a total of about forty-five oystermen and shuckers; average earnings during shellfish season is $4,000 to $5,500;
lease #2	about forty family units with one oysterman and one or two shuckers per family unit; average weekly earnings for oystermen is about $100; average weekly earnings for shuckers is about $75-$100;
lease #3	about fifty family units with one oysterman and one or two shuckers per family unit; average weekly earnings for oystermen is about $100; average weekly earnings for shuckers is $75-$100;
lease #4	a total of about twelve oystermen and shuckers; individual weekly earnings range from $75 to $200;
lease #5	three permanent employees work only with oysters and clams during shellfish season; these permanent employees earn about $5,000 during the shellfish season; about ten part-time employees earn about $2,000 each during the shellfish season;

NOTE:

(1) oysterman - usually male; uses wooden flat-bottom bateau and small outboard engine to transport oysters or clams from the shellfish beds to the shucking house; can only work on low tide; paid by the bushel;

(2) shucker - usually female; opens oysters at the shucking house; can only work after oystermen have gathered shellfish; paid by the gallon of shucked meats;

(3) family unit - an oysterman and one or two women who shuck the oysters he has gathered; oysterman is paid by the number of gallons of shucked meats his crew has produced; he in turn pays his shuckers accordingly; this arrangement does not require that the lease holder balance the number of oystermen and shuckers he employs on a particular day;

(4) survey - conducted by Steve Hopkins, Regional Biologist, South Carolina Wildlife and Marine Resources Department.

into three major categories; raw shucked oysters, cluster or trucked oysters for canning, and select or singles (Tables III-F-9, 10, 11). While only 13% of the oysters harvested are shucked, they provide approximately 52% of the total income to the lease holders. shuckers and pickers (Figure III-F-4). On the other hand, while 86% of the oysters are trucked, they provide only 39% of the total income to the Hilton Head area.

Raw Shucked Oysters. Approximately five major processing operations raw shuck oysters including Hilton Head Seafood Co., Bluffton Oyster Co-operative, Billy Toomer, Hilton Head Oyster Company and S. V. Toomer. The operations of S. V. Toomer and Billy Toomer are presently closed due to their inability to find an adequate number of pickers and shuckers to work their leases and operate their shucking houses. Nonetheless, their leases are being harvested by pickers working for other lease holders. Thad Bailey's shucking house is closed for similar reasons and at present he only trucks oysters. Fifty-one percent of the income paid to employees by all lease holders comes from the harvesting and shucking of oysters while these operations provide lease holders 53 percent of their income. Most oysters are hand shucked by females, although Hilton Head Seafood Company uses the shock method to open oyster shells. By momentarily dipping the oysters into boiling water, their shells are forced open. Hand labor then easily removes the oyster meat. Oyster meat is not cooked but packed raw in containers, iced and sold fresh on the local market.

TABLE III-F-9
DISTRIBUTION OF GROSS INCOMES FROM SHUCKED OYSTER PRODUCTION BETWEEN OYSTER DISTRIBUTORS AND EMPLOYEES IN THE HILTON HEAD AREA, (CALIBOGUE SOUND AND ITS TRIBUTARIES), SEPTEMBER 1978 - JUNE 1979

Major Oyster Distributor	Shucked Oysters (gallons) (1)	Total Dollar Value	Dollars Paid to Employees (2)	Gross Income to Oyster Distributor Before Overhead Taken Out (US Dollars) (3)
1	5,207	$100,651	$ 48,165	$ 52,486
2	3,657	70,690	33,827	36,863
3	320 (4)	6,186	2,960	3,226
4	1,024	19,794	9,472	10,322
5 (5)	-	-	-	-
6 (5)	-	-	-	-
7 (5)	-	-	-	-
8	2,161	41,772	19,989	21,783
Total	12,369	$239,093	$114,413	$124,680

(1) One Gallon = US Bushel/3

(2) Out of the Average of 19.33 Per Gallon Received by Oyster Distributor Approximately 4.50/Gallon is Paid to the Picker and 4.75/Gallon to each Shucker or 9.25/Gallon (Personal Communication Bruce Epler Southern Cooperative Development Fund).

(3) Employees Salaries Already Subtracted.

(4) Lease Holder Operated Only Three Months 1978-79 Season. These Oysters Were Taken Off Lease by Another Lease Holder.

(5) No Oysters Shucked by These Leaseholders.

TABLE III-F-10

DISTRIBUTION OF GROSS INCOMES FROM TRUCKED OYSTER PRODUCTION BETWEEN OYSTER DISTRIBUTORS AND EMPLOYEES IN THE HILTON HEAD AREA, (CALIBOGUE SOUND AND ITS TRIBUTARIES), SEPTEMBER 1978 - JUNE 1979

Major Oyster Distributor	Trucked (1) Oysters (S.C. Bushels)	Total Dollar Value	Dollars (2) Paid to Employees	Gross Income to Oyster (3) Distributor Before Overhead Taken Out (US Dollars)
1	19,570	$ 27,398	$13,699	$13,699
2	26,182	36,655	18,327	18,328
3	11,100	15,540	7,770	7,770
4	-	-		
5	7,500	10,500	5,250	5,250
6	27,000	37,800	18,900	18,900
7	35,000	49,000	24,500	24,500
8 (4)	-	-	-	-
Total	126,352	$176,893	$88,446	$88,447

(1) S.C. Bushels = US Bushel/1.89

(2) Of the $1.40/S.C. Bushel Paid by Ocean, Lake, River and Fish Company, 0.70/Bushel goes to the Pickers (Personal Communication Gilbert Maggioni of Ocean, Lake and River Fish Company, and Bruce Epler Southern Cooperative Development Fund).

(3) Employees Salaries Already Subtracted.

(4) No oysters trucked.

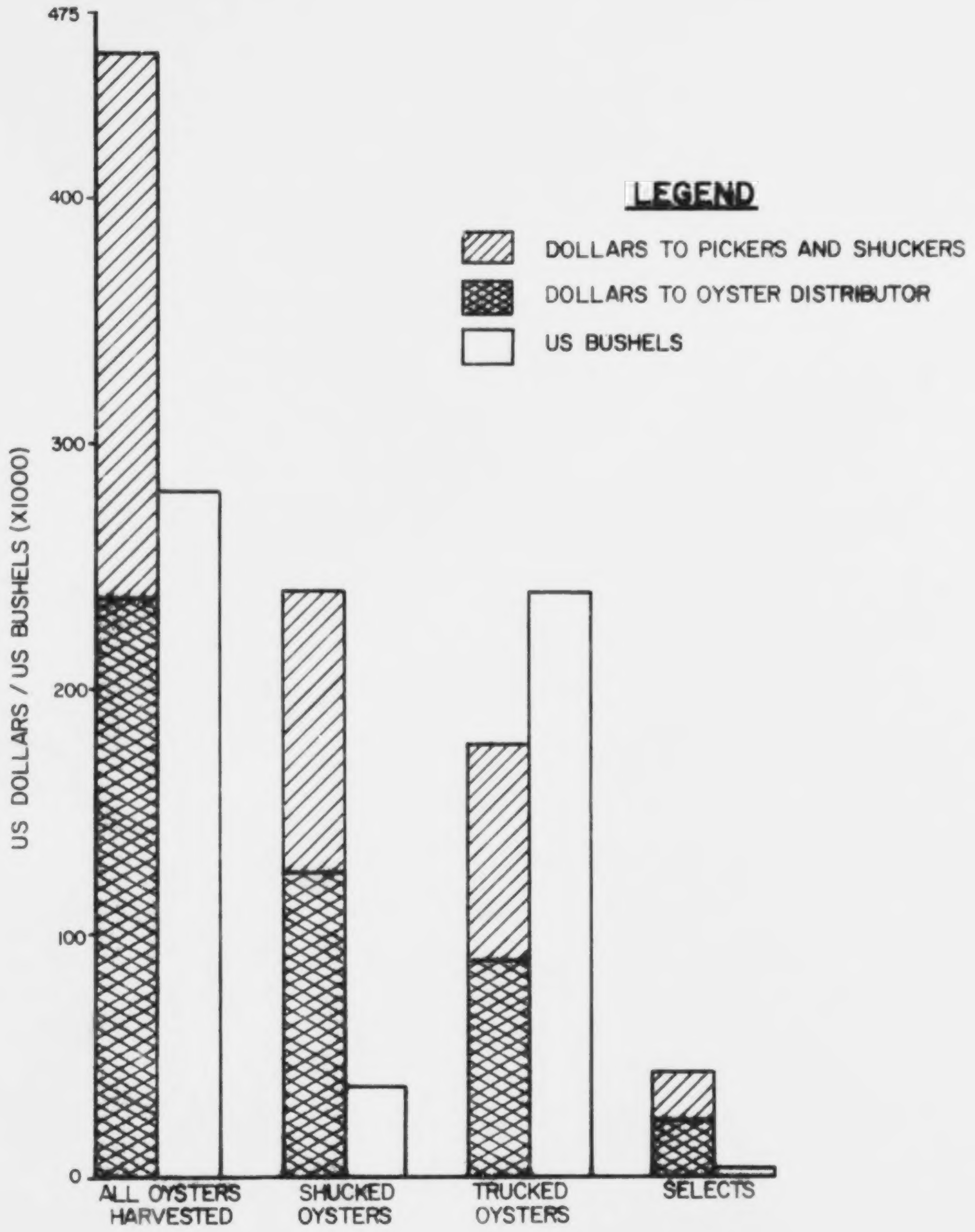
TABLE III-F-11
DISTRIBUTION OF GROSS INCOME FROM SELECT OYSTER PRODUCTION BETWEEN OYSTER DISTRIBUTORS AND EMPLOYEES IN THE HILTON HEAD AREA, (CALIBOGUE SOUND AND ITS TRIBUTARIES), SEPTEMBER 1978-JUNE 1979

Major Oyster Distributor	Select Oysters (US Bushels)	Total Dollar Value(1)	Dollars Paid To Employees	Gross Income to Oyster(2) Distributor Before Overhead Taken Out (US Dollars)
1	745	$ 8,605	$ 3,911	$ 4,694
2	-(3)	-	-	-
3	-	-	-	-
4	-	-	-	-
5	1,700	19,635	8,925	10,710
6	-	-	-	-
7	-	-	-	-
8	1,304	15,061	6,846	8,215
Total...	3,749	$43,301	$19,682	$23,619

(1) Weighed wholesale/retail average of 11.55 paid to Oyster Distributor of which about 5.25/US bushel paid to oyster picker (Personal communication Bruce Epler, Southern Cooperative Development Fund)

(2) Employees salaries already subtracted

(3) Dash indicates lease holder did not deal in significant quantities of select oysters.



DISTRIBUTION OF CATCH AND DOLLARS FROM THE COMMERCIAL OYSTER FISHERY AROUND HILTON HEAD ISLAND BASED UPON 1978 STATISTICS

FIGURE III-F-4

Trucked Oysters. With the exception of Billy Toomer and S. V. Toomer, all major lease holders or oyster distributors truck oysters to Ocean, Lake and River Fish Company, Lady's Island, South Carolina. Oysters in South Carolina "dribble spawn" from June - September at temperatures above 68°F. In more northern states oysters spawn at similar temperatures but in a shorter period, over 2-3 weeks. As a result South Carolina oysters cluster one on top of the other. This clustering inhibits growth of the oysters and is a major reason why local oysters tend to be smaller than northern oysters. Because of dribble spawning, and because air temperatures occurring at water temperatures above 68°F permit a minimum storage period between harvesting and processing before spoilage takes place, Ocean, Lake and River Fish Company does not buy trucked oysters until water temperatures fall below 68° F.

The factory at Lady's Island is highly mechanized. Water pressure from a hose forces deposited oysters on to a conveyor belt which carries the oysters into 20 foot high pressure cookers. This process cooks the meat as well as forces the oyster shells open. After cooking, the oysters, still in the shell, are shoveled on to another conveyor belt and carried to a rotating drum with slats which allows the oyster meat to fall free from the shell. The shells are deposited in a pile while the oyster meats are conveyed on belts where debris is removed and they are canned and autoclaved. These canned oysters are marketed under three brand names throughout the southeast, midwest and in a few western states.

Persons trucking oysters are paid $1.40 per South Carolina bushel (equivalent to 1.89 US bushels). Normally seventy cents of this goes to the oyster pickers. Trucked oysters provide approximately 40 percent of the salaries paid to employees of lease holders and 37 percent of total income to lease holders and distributors before expenses.

Ocean, Lake and River Fish Company, as a major management practice to assure the viability of oyster beds, reseeds the oyster leases around Hilton Head with the quantity of shell required by the State of South Carolina. This shell acts as cultch, providing a surface on which oyster spat (larvae) can settle and grow. In turn this gives the right to Ocean, Lake and River Fish Company to harvest off the various lease holders' oyster beds. It is estimated that between 65-70 percent of the oysters trucked to Ocean, Lake and River Fish Company come from the Hilton Head area. For this reason Ocean, Lake and River Fish Company is greatly concerned about maintaining the harvestability of oyster beds in and around Hilton Head Island.

Select Oysters. Only Bluffton Oyster Cooperative, Hudson Seafood and Hilton Head Seafood Company harvest any significant quantity of select or single oysters. These large oysters normally are taken off a well worked bed located on a hard bottom. They are sold in local restaurants and oyster bars as oyster on the half shell or as roasting oysters. Selects comprise only one percent of all oysters harvested around Hilton Head and bring in approximately 9 percent of the total value in dollars paid to lease holders and distributors. They provide 8 percent of the income obtained by employees and 10 percent of the total income of lease holders before expenses.

CRAB FISHERY

The capture of the blue crab (Callinectes sapidues) by trap exists as a year round fishery and is known as a crab pot fishery. Between January and May when crabs congregate in deeper waters, they are also captured by trawling with bottom nets. Crabs caught by trawling bring a low market value because they contain large quantities of sand which is difficult to separate from the meat. Some distributors and processors refuse to buy crabs collected by trawling.

Crabs are marketed in two forms, processed or cooked, and as bushel crabs (Table III-F-12). The survey indicates approximately 685,000 pounds of whole crab were harvested in 1978. Processed crabs are cooked under pressure, hand picked, and canned or packaged. Three qualities of meat are obtained, lump meat being the large chunks of meat taken from the body of the crab, flake or white meat, and claw meat. The two major crab processors which buy crabs caught around Hilton Head Island are Blue Channel Corporation and Hilton Head Seafood Company. Bluffton Oyster Cooperative is a major supplier of crabs from the Hilton Head area to Blue Channel Corporation. This cooperative, aided by the Southern Cooperative Development Fund, is in the process of opening its own processing and packaging plant. The major season for crab processing is from March through October of each year.

During the winter months, a northern market develops primarily in Maryland and New York as crab catches fall off in these states with the coming of colder weather due to the movement of crabs into deeper waters. Crabbers are paid much higher prices for their catches in this market. As an example

TABLE III-F-12

CRAB PRODUCTION IN THE HILTON HEAD AREA, (CALIBOGUE SOUND AND ITS TRIBUTARIES)

Crab Distributors(8)	Number of Crabbers Employed	Pounds of Whole Crab		Dollars Paid To Crabbers		Gross Income to Distributor(3) Before Overhead Taken Out (Dollars)	
		1978	1979	1978	1979	1978	1979
Bushel Crab (1) Distributor	5 Crabbers	88,630	102,700	$ 31,765	$ 36,808	$ 6,300	$ 7,300
Bushel Crab (1) Distributor	2 Crabbers	192,000	19,200	68,800	68,800	13,600	13,600
Crab (2) Processor	5-6 Crabbers	152,712	88,311 (5)	25,126	15,283	32,523	18,054 (5)
Bushel Crabs (1)	10 Crabbers	67,305 (4)	67,305 (6)	24,123 (4)	24,123 (6)	4,769	4,769 (6)
Processed Crabs (2)	12-20 Pickers	134,610 (6)	134,610 (6)	25,576 (4)	25,576 (6)	25,240	25,240 (6)
Crabs For Restaurant	1 Crabbers	49,920	Projected 49,920	9,485	Projected 9,485	__(7)	__ (7)
TOTAL	23 Crabbers 12-20 Pickers	685,177	462,046	$184,875	$180,075	$82,432	$68,963

(1) Bushel Crab Market (personal communication, Lowther Brothers, Lemon Island Marina, and Mrs. Jack Drawdy of Drawdy's Seafood).

- (a) 1 U.S. Bushel = 40 lb.
- (b) Assume 1/3 of all pounds or bushels are large male crabs, at approximately 6 dozen/bushel.
- (c) 2/3 of all pounds or bushels are small male or female crabs, at approximately 8 dozen/bushel.
- (d) Crabber receives on the average, 19 dollars per U.S. bushel large male crabs. Markup to distributor $3.50/bushel.
- (e) Crabber receives on the average, 12 dollars per U.S. bushel of small male crabs or female crabs, while the distributor receives a mark up of 2.50 dollars per U.S. bushel.

(2) Processed Crabs (personal communication, Rick Dafler, Blue Channel Corporation).

- (a) Between 15-20 cents paid per pound depending on the size of crabs consistently brought in. Price varies with individual crabbers.

- (b) For processed crabs, 14 percent by weight of the raw recorded pounds is meat.

  - (1) 1 percent by weight is lump meat at 5.50 dollars per pound wholesale.
  - (2) 8 percent by weight is white or flake meat at 3.25 dollars per pound wholesale.
  - (3) 5 percent by weight is claw meat at 1.25 dollars per pound wholesale.

(3) Crabbers' salaries already subtracted out.

(4) 1978 catch approximated 1979 records.

(5) March 1979 - October 1979; not a yearly total.

(6) February 1979 - October 1979; not a yearly total.

(7) Not quantifiable.

(8) Major crab distributors: Lemon Island Marina, Drawdy's Seafood, Hudson's Seafood, Hilton Head Seafood Blue Channel Corporation. There is no relation to the above order of information.

crabbers are paid 19 dollars a bushel for large male crabs. At 40 pounds a bushel, this averages out to about 48 cents a pound compared to 15-19 cents a pound paid to crabbers for processed crabs. Because there is some overlap in seasons, crab processors have a difficult time obtaining crabs during the onset of the winter months. "Bushel crabs," as these crabs are called, are delivered live by trucks to the northern states. Large male crabs are preferred by this market, retailing for as much as 15 dollars a dozen. The three primary distributors of bushel crabs from the Hilton Head area include Drawdy's Seafood, Lemon Island Marina and Hilton Head Seafood Company. Drawdy's Seafood has managed to develop a year round market for bushel crabs.

Bushel crabs provide crabbers with approximately 68 percent of their income from the two crab markets (Table III-F-13). Processed crabs provide the distributor with approximately 70% of the total wholesale dollars brought in from both markets.

CLAM PRODUCTION

Since there is very little demand for hard clams (Mercenaria merceraria and Mercenaria campechiensis) in the southeast, most clams are hand harvested and shipped fresh on ice to the northern markets. From observations of catch records, it would appear that the major clam market coincides with the northern bushel crab market from December through May of each year. Hard clams are marketed by size: the smaller Top Necks (shell length less than 50 mm) and Little Necks (shell length 50-65 mm), have the best market value; Cherry Stone follows (shell length 66-79 mm); and the largest chowder clam (shell length greater than 80 mm) has the lowest monetary value. Like oyster

TABLE III-F-13

PERCENT OF PRODUCTION, AND INCOME FROM THE BUSHEL AND PROCESSED CRAB MARKET IN THE HILTON HEAD AREA CRAB FISHERY, 1978

Crab Fishery	Pounds/Percent of Total	Dollars Paid to Crabbers/Percent to Total	Wholesale (3) Gross Income to Distributor Before over-head Taken Out (Dollars)/Percent of Total
Bushel Crabs	347,935/51	124,688/68	24,669/30
Processed Crabs	287,322/42	50,702/27	57,763/70
Other (1)	49,920/ 7	9,485/ 5	- (2)
Total	685,177/100	184,875/100	82,432/100

(1) Restaurant Business
(2) Not Quantifiable Since Crabs Sold in Restaurant, Wholesaler is Bypassed.
(3) Wholesale Profit Has Dollars Paid to Crabbers Subtracted off.

leases, clam leases are obtained from the State of South Carolina. This survey found that seventeen clammers have provided a yearly average of 125,570 pounds of hard clams valued at an average of 99,559 dollars from the Hilton Head area (Table III-F-14).

COMMERCIAL SPORTFISHING

During this survey, various State and national authorities were contacted who are involved in surveying sportfishing in South Carolina. Included were Dr. David Liao of the S. C. Wildlife and Marine Resources Department, and Human Resources Inc. of McLean, Virginia who are surveying sportfishing along the Atlantic Coast for the National Marine Fishery Service. Unfortunately, the information available from these groups was too regional in nature. In order to obtain a grasp of commercial sportfishing around Hilton Head Island, charter boat captains Joe Buckles, Miles Altman and Fuzzy Davis of Palmetto Bay Marina were interviewed. Additionally, statistical data were obtained in conversations with Dick O'Neill, supervisor of the Harbour Town Marina, from which the majority of charter boat activities originate.

The charter boat season begins in the middle of February and terminates in late November or early December. Bluefish (Pomatomus saltatrix) are caught predominantly from May through September. Spanish Mackeral (Scomberomorus sp.) are fished from June through September, while April-December King Mackeral (Scomberomorus cavalla) are fished farther out to sea. It is estimated that 70 percent of the charter boat troll fishery is for snapper blues, (small bluefish of 1-2 pounds), and Spanish Mackeral. Trips average

TABLE III-F-14
CLAM PRODUCTION IN THE HILTON HEAD AREA
(CALIBOGUE SOUND AND ITS TRIBUTARIES)

Clam Distributor	Number of Clammers Employed	Pounds of Clams		Dollars to Clammers		Dollars to (2) Distributors	
		1978		1978	1979	1978	1979
1	4-5	35,720	35,420	$ 16,669	$ 16,520	$ 6,668	$ 6,608
2	12	90,000	90,000	42,000	42,000	16,800	16,800
3	- (1)	0	0	0	0	0	0
4	- (1)	0	0	0	0	0	0
Total	17	125,720	125,420	$ 58,669	$ 58,520	$ 23,468	$ 23,408

(1) No Clams Taken in the Hilton Head Area.
(2) Clammers' Salaries Already Subtracted Out.
(3) 75 Pounds / US Bushel
(4) Approximately 700 Cherry/Little, Top Necks Per US Bushel. Little or No Dealings in Chowder Clams.
(5) 5 Cents Paid Per Clam to Clammers.
(6) 2 Cents Mark Up for Distributor.
(7) Major Clam Distributors Interviewed With No Relation to the Above Order; Coastal Sea Food, Lemon Island Marina, Hudson's Seafood, Drawdy's Seafood.

four hours in length. Some live bait fishing takes place for barracuda and amberjack. Cobia (*Rachycemtrom canadum*) is also taken.

Twenty percent of the troll fishery consists of 8-9 hour trips primarily for King Mackeral, as well as albacore (*Thunnus alalunga*), amberjack (*Seriola* sp.), dolphin (*Coryphaena hippurus*), sailfish (*Istiophorus orientalis*) and baracudda (*Sphyraena* sp.).

There is an increasing demand to charter longer trips, 15 hours dock to dock, to the Gulf Stream lying 65-80 nautical miles off-shore. Trolling takes place for Blue Marlin (*Makaire bleu*) and to a lesser degree White Marlin (*Makaire blanc*) in April and May. Swordfish (*Xiphias gladius*) are fished at night. Also taken are sailfish (*Istiophorus orientalis*), dolphin, wahoo, yellowfin tuna (*Thunnus alalunga*) and blackfin tuna (*Thunnus* sp.).

There are nine open water charter boats fishing regularly off Hilton Head Island. Most trips are chartered out of Harbour Town Marina. At the peak of the season another 8-10 charter boats are called upon by Harbour Town Marina that originate out of Savannah and Beaufort. Another 6 trolling boats charter out of Hilton Head Harbour and Palmetto Bay Marina. Additionally, Harbour Town Marina operates a Head Boat that carries up to 40 people to bottom fish. Fifty percent of the Head Boat's time is spent fishing in the sounds for shark and bottom fish. On calmer days (the other 50 percent) trips are made to off-shore reefs to fish primarily for Black Sea Bass (*Centropristis striatus*). One charter boat captain has recently begun taking out groups to fish intercoastal waters for spotted sea-trout (*Cynoscion regalis*) and Channel Bass (Red Fish, *Sciaenops ocellata*).

With at least another month of fishing, this survey estimates that charter boat revenues could run from 550,000 to 600,000 dollars a year (Table III-F-15). Dick O'Neill believes demands for charter boat fishing are increasing yearly. He also explained that another 50,000 dollars or more of yearly revenue to Hilton Head can be expected from private boats that dock at Harbour Town and other marinas for the purpose of sportfishing.

It should be understood that many of the sportfish such as the blue fish, spanish mackeral, speckled trout, and channel bass spend a portion of their life cycles in and around the estuaries of Hilton Head Island. Pollution of the estuaries has a great potential to adversely impact this industry.

COMMERCIAL FIN FISHERY

An inshore gill net fishery exists for spotted sea-trout, red drum and flounder. No information was obtained on the value of this fishery. Spot, whiting and flounder also show up in the incidental catches of the shrimp trawlers. No information was obtained on the value of this fishery.

TABLE III-F-15
VALUE OF COMMERCIAL SPORT FISHING TO HILTON HEAD ISLAND

Marina	Number of Commercial Sport Fishing Boats	Gross Value Dollars	Approximate Number Of Trips Yearly	Approximate Number Of Sport Fisherman Yearly
Harbour Town Marina	6 Boats from Marina	$230,500 (1)	922	3,688
	1 Head Boat	67,000 (2)	112	3,350
	8-10 Boats from Outside Marina	25,000 (1)	100	400
Palmetto Bay Marine	2 Large Open Water Boats	$ 75,000 (3)	300	1,200
	1 Intermediate Sized Boat	11,200 (4)	80	320
	1 Inter-Coastal Fishing Boat	6,375 (5)	75	225
Hilton Head Harbor	3 Open Water Troll Boats	$112,500	450	1,800
TOTAL...	Up to 24 Boats at Peak Season	$527,575	2,039	10,983

---

(1) Average trip 5 hours at $250/trip, 4 persons per trip, Jan. 1 - Oct. 31, 1979, (Personal communication Dick O'Neill, Harbour Town Marina).

(2) Average number of persons per head boat trip of 30, Jan. 1 - Oct. 31, 1979, (Personal communication Harbour Town Marina).

(3) Approximately 150 trips/year/boat, averaging 5 hours/trip, at $250/trip, 4 persons per trip (Personal communication Joe Buckles, Palmetto Bay Marina).

(4) Approximately 4 persons per trip at 140 dollars/4 hour trip, average per year, (Personal communication Miles Altman, Palmetto Bay Marina).

(5) Approximately 3 persons per trip at 85 dollars/5 hour trip, July-Oct. 1979 in first season of operation; (Personal communication Fuzzy Davis, Palmetto Bay Marina).

CHAPTER III-G

ARCHEOLOGICAL/HISTORICAL RESOURCES

A total of 24 archeological and historical sites on Hilton Head Island are registered in the files of the University of South Carolina Institute of Archeology and Anthropology. Of these, nine sites are prehistoric, 11 are historic, and four have both prehistoric and historic components. As of the fall of 1979, no systematic survey of the entirety of the island had been done, and many other unrecorded sites are thought to exist (based upon correspondence with William H. Marquardt, Associate Director, Institute of Archeology and Anthropology, October 2, 1979). Therefore, areas affected by recommended wastewater management facilities should receive a thorough ground survey prior to disturbance.

PREHISTORIC RESOURCES

The archeological resources of South Carolina and neighboring states are documented as early as 14,000 years ago. However, archeological investigations in coastal South Carolina and Georgia have found no intact Paleo-Indian (12,000-8,000 B.C.), Early Archaic (8,000 - 6,000 B.C.), or Middle Archaic (6,000 - 4,000 B.C.) prehistoric components. This lack of evidence is often attributed to the changes in sea levels and topography which took place during those periods. Moreover, some of the coastal barrier islands of the Atlantic southeast have been formed only within the last 1,200 years.

Hilton Head Island contains archeological remains radiocarbon dated as early as 1940 B.C. from the Late Archaic Period (4,000 1,000 B.C.). This period is relatively well known in coastal South Carolina and is characterized by numerous shell rings and shell middens left by Indians whose culture consisted of a seasonally based hunting and gathering subsistence strategy.

In 1968, Professor Alan Calmes presented a paper on his excavations of three shell rings on Hilton Head Island. The Large Ford Shell Ring and the Small Ford (or Green's) Shell Ring are located at the north end of the island near Skull Creek. The third is located at Sea Pines Plantation in the Forest Preserve. All are listed on the National Register of Historic Places.

The Large Ford Shell Ring is doughnut-shaped with a low, clear, circular center in the middle and is two hundred feet in diameter. The ring portion of the mound is fifty feet wide at the base, it slopes very gradually up both sides to an average height of six feet. The top portion of the apex tends to be flat. The site was almost entirely destroyed in the 1930's when much of the shell was used for road beds on the island. The Small Ford Shell Ring, adjacent to and overlapped by the Large Ford Shell Ring, differs from the larger ring in that it is only two feet high at the apex and encloses a smaller area. The third shell ring, the

Sea Pines Shell Ring, is on the southern end of Hilton Head Island. It consists of oyster shells piled up in the shape of a ridge curving through the woods to form an irregular circle with a diameter of one hundred and twenty feet. The ridge of shell varies in depth from one to three feet at the apex and is about thirty feet wide at the base.

The rings contained numerous small piles about seven or eight feet in diameter and two feet high. The shell was crushed on top of the piles. Pottery sherds and charcoal were found on top, while the central portions of the piles were composed of very loosely packed unbroken shell. The bands of crushed shell and pottery sherds followed the tops of the successive piles which were built up on top of one another, thus indicating possible human occupation over a long period of time. The Indians possibly lived in a circle or disposed of their refuse in a circle. The pile of debris may have been walked over or lived upon, causing the shell on top to be crushed and to contain a relatively concentrated amount of charcoal and pottery sherds.

The pottery types found at the three sites were classified as either Stalling's Island Fiber Tempered Decorated or Thom's Creek. Most of the pottery from these sites was of the sand tempered Thom's Creek type. The main decorative motifs were finger-nail marked, punctate, multiple drag and jab, and plain. Examples of incising were rare.

The few non-ceramic items screened out of these test excavations included Savannah River stemmed projectile points, conch shell tools, a fired round ball of clay with a hole through the middle, and scroll-designed decorated bone pins.

Radiocarbon dates of organic material from the shell rings seem to indicate that the rings were formed over a long period of time. Charcoal from the bottom level of the Small Ford Shell Ring was dated at 1940 B.C., indicating that it underlies the big ring. Also, on the basis of ceramics, the small ring appeared to be of a different and possibly an earlier period of time than the large shell ring.

Based upon dating of charcoal samples and oyster shell, the Late Archaic Indians at the Large Ford Shell Ring began either living in a circle or throwing their refuse in a circle sometime before 1635 B.C. They did not complete the shell ring until sometime after 1170 B.C.

A clam shell from the bottom of the Sea Pines Shell Ring dated the beginning of occupation of that site at 1450 B.C. Small conch shells from the top level registered a radiocarbon date of 1160 B.C. The same people who possibly periodically occupied the Large Ford Shell Ring may have regularly camped at the Sea Pines Site. Pottery sherds from the last top levels of the Large Ford Shell Ring corresponded with those from the Sea Pines Shell Ring.

The Late Archaic Period was succeeded by the Woodland Period (1000 B.C. - 1000 A.D.) which demonstrated a continuation of the earlier subsistence culture. Some researchers suggest horticulture may have begun during this period. The Mississippian Period (1000 A.D. - European Contact) was characterized by intensive agriculture, sedentary populations, and highly stratified socio-political structures.

HISTORIC RESOURCES

In 1520 the Spaniard Francisco Cordillo first made contact with local Indian tribes. Six years later, a Spanish explorer Pedro de Quexos became the first European known to have landed on Hilton Head Island. Spanish Wells, between Broad Creek and Calibogue Sound, is the reputed site of wells used to supply early colonial Spanish ships.

The island was claimed by the French in 1562 by the Huguenot leader Jean Ribaut who attempted to establish a settlement named Charlesfort on Parris Island. Charlesport was soon abandoned and its remains destroyed by the Spanish in 1564. San Felipe was built nearby in order to re-establish the Spanish presence and served as the northernmost of a chain of missions along the South Atlantic coast.

For the next hundred years Spain, France, and their Indian allies fought each other for a secure foothold in the New World. Neither was successful and in 1670 the English established what became Charleston. In 1663, Captain William Hilton claimed the island for the British while searching for an area in which planters from Barbados might settle.

Twenty-three tribes were indigenous to the coast of South Carolina at the time of European settlement. They formed a defensive confederation, called the Cusabo, which included tribes between the Santee and Savannah Rivers.

The first permanent settler on Hilton Head Island was John Barnwell who established a plantation in the northwest portion of the island in 1717. Despite threats of Spanish and pirate attacks and the Yemassee Wars of the first third of the century, settlers continued to come to the island. Documents record 25 families established by 1766.

During the Revolution, the islanders largely supported the Colonial cause and maintained constant guerilla activity with Tory residents of neighboring Daufuskie Island. A Revolutionary War ambush site on what is now Port Royal Plantation commemorates this era. The Zion Church of Ease Cemetery at the intersection of Matthews Drive and Highway 278 contains the graves of many early settlers dating from 1786.

The first long staple cotton crop was grown by William Elliott at Myrtle Bank Plantation in 1790. During the early 1800's small farming operations were consolidated for optimum cotton production and approximately 15 families controlled 28,000 acres. Most planters maintained houses in Beaufort and Charleston as their primary residences. Therefore, the plantation houses on the island were basically comfortable country places. None has survived the Civil War and Reconstruction.

The island was captured by Union forces after the Battle of Port Royal in November, 1861. For the next three years, Hilton Head Island became the headquarters of the Union's Department of the South and served as a base for the blockade of the Charleston and Savannah harbors. Twenty-five thousand troops and a civilian contingent occupied the northern end of the island in the Port Royal area. Various historic sites remaining include:

- Braddock Point. Remains of Confederate earthworks constructed around 1861 on the southern end of the island.
- Easterbrook Battery. A Confederate artillery battery on Calibogue Sound near Palmetto Bay. Later renamed Battery Holbrook after captured by the Union.
- Ft. Walker. Originally constructed in May 1861 by the Confederate forces to guard entrance to Port Royal Sound. It was captured in November 1861 and renamed Ft. Wells.
- A series of forts built by the Union on the northern end of the island in 1862 - 64: Fort Gilmore, Fort Howell, Fort Mitchel, and Fort Sherman. The sites are located at Hilton Head Plantation, Port Royal Plantation, and Palmetto Dunes Resort.
- The Hilton Head Lighthouse. Erected by the Union in 1861 on what was Leamington Plantation, now Palmetto Dunes Resort.

Historic resources dating from the turn of the century include the wreckage of the Steam Cannon, a piece of steam propelled artillery developed at the time of the Spanish-American War (1898). The cannon can be found on the beach at Port Royal Plantation. It was intended for the defense of Port Royal Sound but was never fired.

CHAPTER III-H

RECREATION

The development of Hilton Head Island has been resort oriented since the early 1950's, mainly according to the plantation concept. The plantations are large scale planned developments containing residential and recreational land uses, with a few commercial nodes. Much of the recreation supply for Hilton Head is furnished by the private sector. However, many islanders are barred for economic reasons from availing themselves of private recreational resources and must rely on public recreational opportunities.

Both public and private recreation opportunities will be discussed in the following sections of this chapter.

PRIVATE RECREATION

Private recreation opportunities are owned and operated by commercial enterprises. They are accessible to members and guests or to the general public for a fee.

Inventory

The island presently contains twelve 18-hole golf courses, several of which are sites of national golf tournaments. All courses are contained within plantations and are available to members and guests. The island also possesses 125 private tennis courts and six paddle tennis courts, all of which are associated with plantation raquet clubs or resort facilities.

Two stables are located on the island at Sea Pines Plantation and Hilton Head Plantation. Supervised trail rides and beach rides can be arranged. Sea Pines Plantation possesses over 12 miles of bicycle paths, and bicycles can be rented at a number of shops. Polo matches are scheduled every Sunday afternoon, and the public is invited.

Many opportunities exist for hiking and nature watching. Deer, raccoon, opossums, bobcats, loggerhead turtles, squirrels, grey foxes, and alligators can be seen. The 600-acre Forest Preserve at Sea Pines Plantation is a particularly fine area for nature study. Cypress Swamp Rookery, a nesting area for the rare osprey, can be viewed from a 60-foot tower at Hilton Head Plantation. Whooping Crane Pond, a 137-acre tract, is inhabited by ibis, egrets, and a variety of wading birds.

A wide range of salt water and fresh water fishing is available. Many residents own boats, and six marinas offer charter and other services. Sailing, sightseeing cruises, water skiing, and power boating can be arranged through rental agencies.

A water slide has recently opened at South Forest Beach. All plantations and other resorts provide swimming pools and/or beach access.

Sea Pines Academy, a private school, has a playground and gymnasium which is made available to the public for a fee.

Assessment

Private recreation opportunities have been developed in parallel with the market demand of plantation residents and resort visitors, and an abundant supply of private recreational facilities exists.

PUBLIC RECREATION

Publicly financed facilities on the island do not meet the needs of those who cannot afford private recreation opportunities. For example, the island contains no public golf courses, no public gymnasiums, no public swimming pools, no designated bike trails outside the plantations, and no public campgrounds.

Inventory

The Beaufort County Open Space and Recreation Plan, 1977-2000 contains an inventory of publicly financed recreation facilities. The old Hilton Head School, now the Beaufort County Courthouse Annex, is located on a six-acre tract. A summer program is operated out of one room in the building. The program offers free lunches, table games, art lessons, an exercise program, and rap sessions. Outside are two tennis courts, playground equipment, and a basketball court. A van takes children to Camp St. Mary's on the mainland for swimming lessons. Eighty children were served during the summer of 1979. The Recreation Commission has announced

$12,000 in improvements including tennis court lighting, construction of a picnic shelter, and a water fountain for the Courthouse Annex.

The Hilton Head Elementary School located on the north end of the island occupies a three-acre site. A playground, a tot lot, and basketball goals are available for public recreation. Gator Field, privately held on a long-term lease and soon to be deeded to the County, serves as a seven-acre community park on the northern end of the island. A five-acre community sandlot baseball field is privately owned but used by community teams.

Individuals and groups within the community have structured a number of recreational activities: the Hilton Head Bluejays baseball team, youth baseball teams, a rugby team, men's and youth soccer teams, the Hilton Head Gators and Bluffton Crusaders little league football teams, youth and men's basketball leagues, men and women's volleyball leagues, tennis instruction clinics and tennis tournaments, men's and women's softball leagues, a polo team, youth bicycle races, Gator youth track teams, and "all-comers" track meets. Except for $5500 in County support for the Gators and Crusaders, these recreational opportunities are the results of volunteer labor and fund raising in the private sector.

Ground was broken in November, 1979, for the construction of the Island Youth Center on Cordillo Parkway. The Center is a project of the Hilton Head Rotary Club, which has been conducting an intensive fundraising effort to secure $250,000 to finance the building. In addition, six acres of adjacent land, which the Sea Pines Company and the Association of Sea Pines Property Owners have agreed to allow the Center to use, will be improved into athletic fields. The Center is a private, non-profit organization governed by a board of directors whose goal is to service moral, psychological, and physical needs of all the island's youth.

The Newhall Wildlife Preserve on Palmetto Bay Road is a 50-acre tract owned and operated by the Hilton Head Audubon Society. Admission is free to the public and guided tours are offered.

In the mid-1970's Pinckney Island and the smaller Little Harry, Big Harry, and Corn Islands, were donated to the U. S. Fish and Wildlife Service by the owners. The islands' 4,053 acres will be used for research and conservation purposes. In the future, limited day use may be allowed, much as it is at the Savannah River Refuge.

The County contains approximately 245 square miles of tidal salt marsh and 131 square miles of open water in a protected sound, bay, and salt water rivers and creeks. These waters provide excellent opportunities for boating and fishing. Currently, Beaufort County owns and maintains a boat ramp on a three-acre site on Marshland Road, and the State maintains an artificial fishing reef in Broad Creek.

Assessment

The South Carolina Department of Parks and Recreation suggests the following standards:

- Neighborhood parks: 3 acres/1000 population, 3-6 acres per park
- Community parks: 3 acres/1000 population, 30 acres per park
- Urban parks: 6 acres/1000 population, 100-300 acres per park

The Open Space and Recreation Plan recommends a series of 11 neighborhood parks on the island. Each should contain a playground and playground equipment, tot lots, basketball goals, and a landscaped passive recreation area. This number of parks may not be justifiable if parks standards are literally interpreted to require 1000 public consumers per park service area.

The Open Space and Recreation Plan also proposes that the County acquire 15 to 18 acres adjacent to Gator Field for development into a community park. Facilities would include additional lighted baseball and football fields, tennis courts, a swimming pool and bath house, and a gym and indoor recreation center. An additional community park is suggested in conjunction with a proposed junior high school or high school which may be built to absorb a student overload at McCracken High School in Bluffton. At least one of these parks is badly needed now.

The number of public recreation consumers on Hilton Head may not reach a size where an urban park will be justified by the year 2000, although the South Carolina Outdoor Recreation Plan (1975 ed.) calls for a new state district park to be located on the island. The park would contain 200-500 acres intensively programmed to serve the day use needs of a 10-20 mile service area which would include much of lower Beaufort County. A 60-acre site on the Singleton Beach area was proposed for this park, but funds were not available for land acquisition. The tract has now passed to a private developer.

Development of privately-held lands adjacent to the 14 miles of public beaches has made public access economically impractical except at two points. The State of South Carolina owns the Pope Avenue access point (Coligny Circle) at the south end of the island in the Forest Beach area. The public has used an access point in the Singleton/Bradley Beach area, but the point is private property and could be closed at any time. These two points provide access to only two miles of public beaches, which is inadequate to meet the needs of local citizens and off-island day visitors. The Open Space and Recreation Plan estimates that 8,000 out-of-county visitors use Hilton Head beaches and 10,000 use Hunting Island beaches on a summer weekend in addition to local citizens. Given a standard of 25 feet of beach per 100 population, countywide demand rises to 97 miles of beaches. In contrast, the county contains 36 miles of beaches, and only four are easily accessible to the general public.

In August, 1979, a 10-foot public access easement from the end of Folly Field Road to the beach was offered to the County by the developers who purchased the 60-acre tract previouslv proposed for a district park. This new public access point will alleviate demand slightly.

SUMMARY

Hilton Head Island represents the rare case where a substantial portion of the local recreation demand is supplied by the private sector. Private recreation opportunities on the island are more than adequate to meet demand and can be expected to keep pace with development. Studies undertaken by local planning agencies show severe deficits in public recreation opportunities. Major public spending programs will be required to provide additional public recreation opportunities, since land and construction costs are high on the island.

CHAPTER III-I

WATER SUPPLY

Although water supply is not an issue, per se, in this environmental impact statement, it is such a very sensitive resource and has recently been the subject of sufficient concern that the SCWRC has recommended that Hilton Head Island and the entire Lowcountry area be declared a capacity use area. Most water for domestic, public supply, farming, and irrigation needs on Hilton Head Island is pumped from the principal artesian aquifer. Some Black residents in the northern and central parts of the island still use shallow wells into the Hawthorn aquifer and unnamed Pleistocene deposits. In view of the increasing demands on Hilton Head Island for both water supply and wastewater disposal, it is essential that alternatives be developed which will accomodate the future demands without degrading existing and future water supply sources.

SOURCES OF WATER SUPPLY AND WATER SYSTEMS

The primary source of water for users on Hilton Head Island is the upper permeable zone of the principal artesian aquifer. The principal artesian aquifer is comprised of the Santee Limesto[illegible] and the lower part of the Cooper Marl of the Tertiary System. The hydrogeological characteristics of this aquifer were described and discussed in the

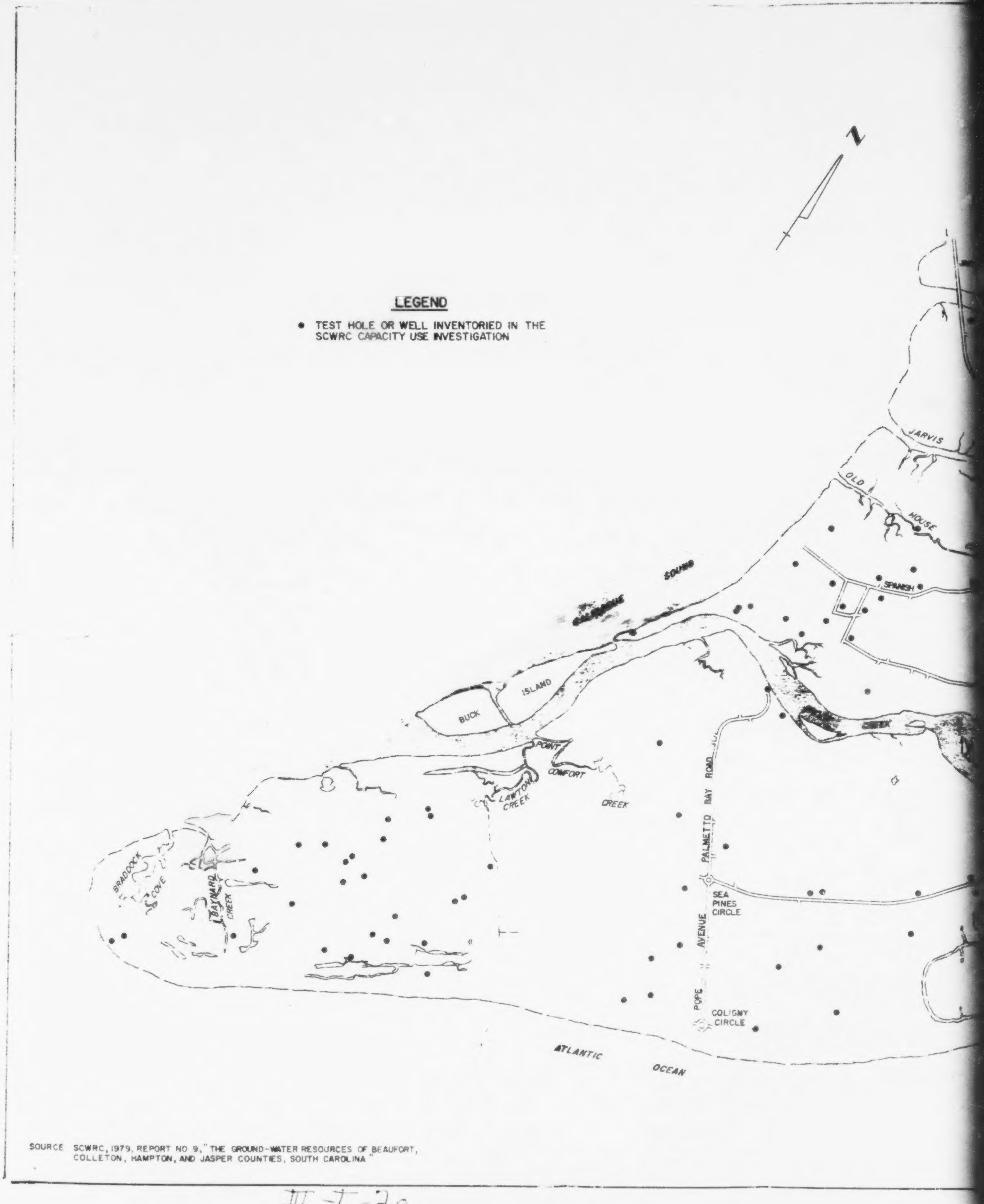
"Ground Water Resources" section (Chapter II-H) of this report.

In 1976, about 3.2 billion gallons (8.6 mgd) of ground water were pumped from the principal artesian aquifer for usage on Hilton Head Island. Approximately 61 percent, or 1.9 billion gallons (5.2 mgd), were used for golf course irrigation; public supply usage accounted for another 38 percent, or 1.2 billion gallons (3.3 mgd); and the remaining 1 percent or 0.05 billion gallons (0.1 mgd) was rural, domestic usage.

The South Carolina Water Resources Commission (SCWRC) estimated that there were about 175 wells on Hilton Head Island in 1976. Plate III-I-1 shows the location of the wells which the SCWRC inventoried and employed in their Phase I capacity use investigation. In spring 1980, the SCWRC estimated that there were about 250 wells on Hilton Head Island.

There are three basic types of water systems on the island: public water supply systems, supplying potable water to residential and commercial users; rural-domestic (single- or multi-family) systems; and the golf course irrigation systems. The public water supply systems can be subdivided into the type of ownership: public service districts, private firm or company, or owned by an individual.

Water use data is limited because currently only the wells serving public drinking water systems are required to be permitted by DHEC. These systems are required to meet the water quality standards of the National Interim Primary Drinking Water Regulations (NIPDWR) as provided


N
JARVIS
OLD HOUSE
SPANISH
CALIBOGUE SOUND
BUCK ISLAND
POINT COMFORT CREEK
LAWTON CREEK
CREEK
BRADDOCK COVE
BAYNARD CREEK
PALMETTO BAY ROAD
POPE AVENUE
SEA PINES CIRCLE
COLIGMY CIRCLE
ATLANTIC OCEAN

LEGEND

● TEST HOLE OR WELL INVENTORIED IN THE SCWRC CAPACITY USE INVESTIGATION

SOURCE SCWRC, 1979, REPORT NO 9, "THE GROUND-WATER RESOURCES OF BEAUFORT, COLLETON, HAMPTON, AND JASPER COUNTIES, SOUTH CAROLINA"

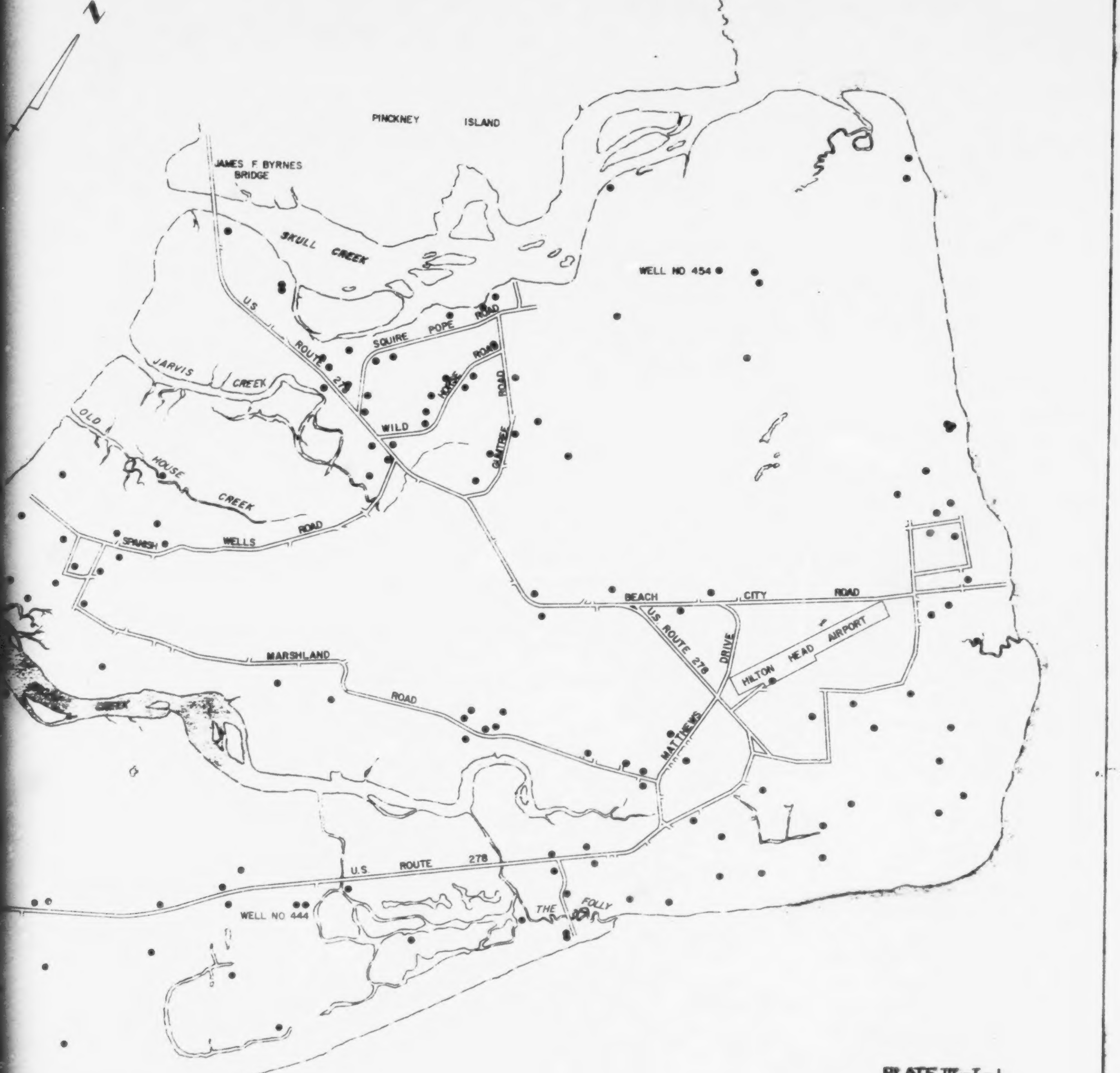

N
PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
WELL NO 454
U.S. ROUTE 278
SQUIRE POPE ROAD
JARVIS CREEK
WILD HORSE ROAD
GUMTREE ROAD
OLD HOUSE CREEK
SPANISH WELLS ROAD
BEACH CITY ROAD
U.S. ROUTE 278
MATTHEWS DRIVE
HILTON HEAD AIRPORT
MARSHLAND ROAD
CREEK
U.S. ROUTE 278
THE FOLLY
WELL NO 444

PLATE III-I-1

HILTON HEAD ISLAND
SOUTH CAROLINA

1976 WELL CAPACITY USE INVESTIGATION

3000
0
3000
6000
SCALE IN FEET

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

for by the Safe Drinking Water Act (SDWA), Public Law 93-523, enacted on December 16, 1974. These NIPDWR became effective on June 24, 1977, and established monitoring requirements and maximum levels of chemical, physical, bacteriological, and radiological contaminants in drinking water. As provided for by the SDWA, South Carolina, through DHEC, assumed the option of providing the surveillance, monitoring, and enforcement activities to carry out the requirements of the Act (primacy).

The Act defines a public water supply as "a system for the provision to the public of piped water for human consumption, if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year". Public water supplies are classified by the Act's regulations as community systems or non-community systems. A community system has at least 15 service connections used by year-round residents or serves at least 25 year-round residents. A non-community system has at least 15 service connections used by travelers or intermittent users at least 60 days a year or serves a daily average of at least 25 people at least 60 days a year.

According to records provided by the Water Supply Division of DHEC in March, 1980, there are 22 public water supply systems located on Hilton Head Island. These systems are identified in Table III-I-1, along with other information contained in the DHEC files.

Further investigation resulted in four additional water supply

TABLE III-I-1

INVENTORY OF PUBLIC WATER SUPPLY SYSTEMS[1]

DHEC Station Code[2]	System Name	Number of Wells	Number of Service Connections	Number of Meters	Retail Population Served	Last Update
207001	Sea Pines PSD	10	-[3]	1,600	2,922	09/27/77
207006	Hilton Head No. 1 PSD	5	-	-	455	08/14/75
207007	Hilton Head Plantation	2	-	-	402	10/04/78
207008	Forest Beach PSD	5	-	1,175	886	07/26/76
307005	Island Ice, Inc.	1	1	-	-	11/14/78
507006	Hilton Head Island Utility 1	2	65	65	210	07/12/78
507011	Hilton Head Island Utility 2	2	21	-	74	07/14/78
507014	Broad Creek PSD	4	37	-	130	08/05/75
507020	Hilton Head Island Utility 3	1	-	-	8	07/12/78
607002	Otter Hole Trailer Park	4	24	-	80	07/25/78
607026	Bay Trailer Park	1	18	-	63	12/28/76
607053	Broad Creek Trailer Park	1	40	-	140	03/24/77
607064	Squire Mobile Home Park	1	9	-	14	07/12/76

TABLE III-I-1 (Cont'd)

INVENTORY OF PUBLIC WATER SUPPLY SYSTEMS[1]

DHEC Station Code[2]	System Name	Number of Wells	Number of Service Connections	Number of Meters	Retail Population Served	Last Update
607066	Reliance Trailer Park	1	8	7	17	10/09/78
607067	Northside Mobile Home Park	1	41	1	-	05/20/77
707001	Hilton Head Hospital	1	-	-	-	05/20/77
707107	Hilton Head	1	-	-	-	06/23/72
707216	Roadside Rest	1	-	-	-	03/11/75
707220	Hudson Restaurant	1	-	-	-	08/05/75
707222	Sand Trap Foods	1	-	-	-	06/28/76
707850	Hilton Head Harbor	1	45	-	158	08/14/75
707851	Palmetto Bay	1	60	-	175	06/26/78
	Spanish Wells Road[4]	1	7	-	-	--
	Muddy Creek[4]	1	22	-	-	--
	Baygall-Barker Field[4]	1	18	-	-	--
	Squire's Gate Subdivision	1	49	-	-	--

TABLE III-I-1 (Cont'd)

INVENTORY OF PUBLIC WATER SUPPLY SYSTEMS[1]

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[1] Source: South Carolina Department of Health and Environmental Control, Water Supply Division, March 24, 1980; Mr. J. Y. Pitts, Jr., Hilton Head Utilities, Inc.; Mr. Erik H. Freiesleben, Freiesleben-Yerkes, Inc.

[2] DHEC Station Code - Keyed to Plate III-I-2.

[3] Not Available.

[4] Cluster Well - Deep Well Project.

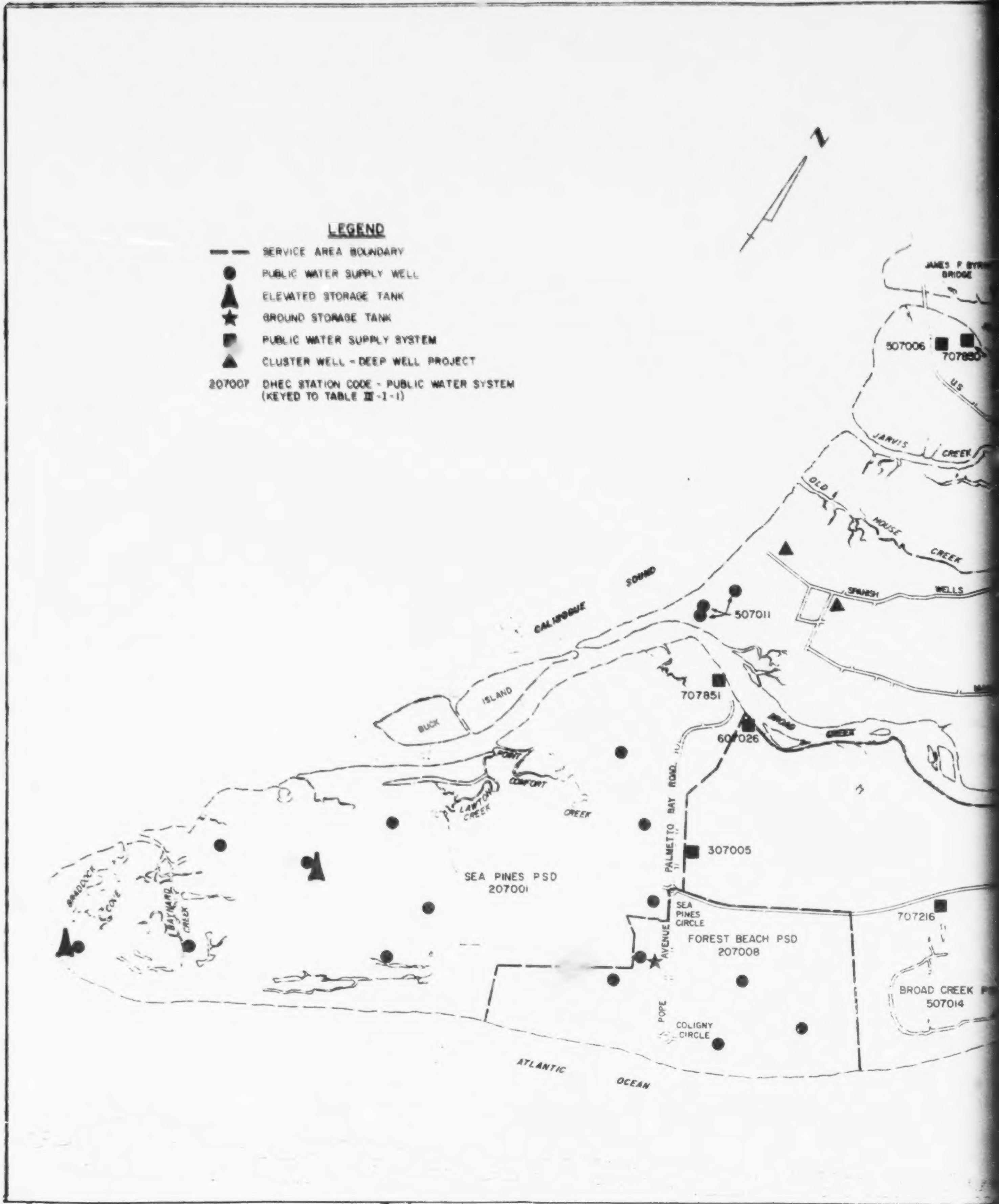
systems that have been inspected, approved for operation, and permitted by DHEC; however, these systems are not included in DHEC's master file. These four systems are also listed in Table III-I-1 and discussed later.

All public water supply systems are mapped on Plate III-I-2. Individual wells and storage facilities are located only for the public service district systems and private water companies.

The following sections describe the public service district systems, the private water companies, and the rural-domestic systems for which additional information was available.

Sea Pines PSD - The water system for the Sea Pines Public Service District consists of 10 wells and two 300,000-gallon elevated storage tanks. All the wells penetrate the upper permeable zone of the principal artesian aquifer. Table III-I-2 lists pertinent information for the wells in the Sea Pines PSD system and the locations are shown on Plate III-I-2.

The Sea Pines Public Service District has the distribution system split into three meter-reading cycles so that all meters are read once every three months. The billings are separated into single-family, multi-family, and commercial accounts. Table III-I-3 shows the monthly usage by account type for 1978. These figures are water billings; the quantities of water pumped into the distribution system are probably greater due to unaccountable usages.


N
LEGEND
SERVICE AREA BOUNDARY
PUBLIC WATER SUPPLY WELL
ELEVATED STORAGE TANK
GROUND STORAGE TANK
PUBLIC WATER SUPPLY SYSTEM
CLUSTER WELL - DEEP WELL PROJECT
207007 DHEC STATION CODE - PUBLIC WATER SYSTEM (KEYED TO TABLE III-1-1)
JAMES F BYRN
BRIDGE
507006
707850
US
JARVIS CREEK
OLD HOUSE CREEK
SPANISH WELLS
CALIBOGUE SOUND
507011
BUCK ISLAND
707851
607026
BROAD CREEK
PORT COMFORT CREEK
LAWTON CREEK
PALMETTO BAY ROAD
307005
SEA PINES PSD
207001
BRADDOCK COVE
BAYNARD CREEK
SEA PINES CIRCLE
FOREST BEACH PSD
207008
707216
AVENUE
POPE
COLIGNY CIRCLE
BROAD CREEK P
507014
ATLANTIC OCEAN

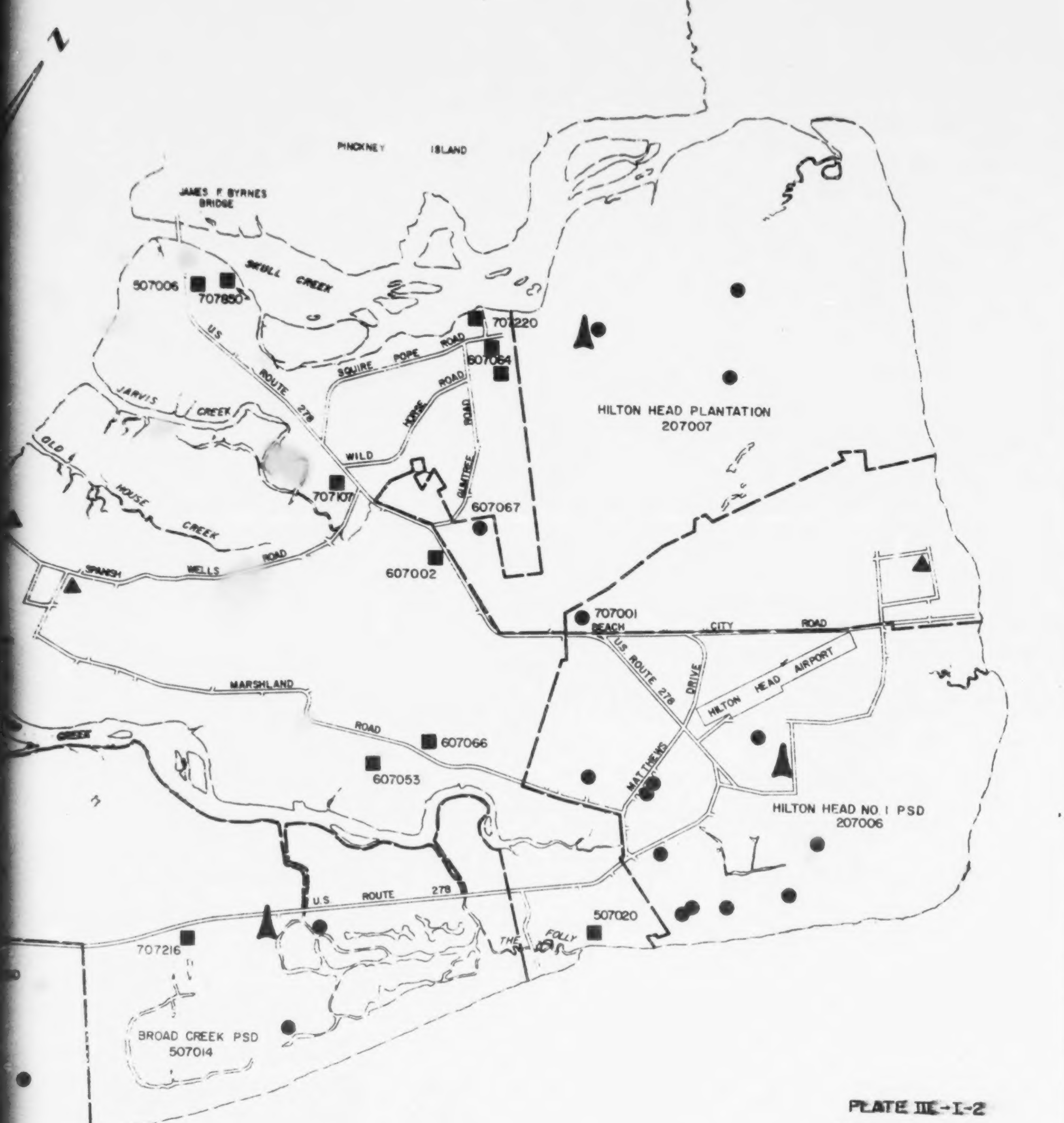

N
PINCKNEY ISLAND
JAMES F. BYRNES BRIDGE
SKULL CREEK
507006
707650
707220
607064
US ROUTE 278
SQUIRE POPE ROAD
HORSE ROAD
GUMTREE ROAD
WILD
JARVIS CREEK
OLD HOUSE CREEK
707107
607067
607002
SPANISH WELLS ROAD
HILTON HEAD PLANTATION
207007
707001
BEACH CITY ROAD
US ROUTE 278
DRIVE
HILTON HEAD AIRPORT
MARSHLAND ROAD
CREEK
607066
607053
MATTHEWS
HILTON HEAD NO. 1 PSD
207006
U.S. ROUTE 278
507020
THE FOLLY
707216
BROAD CREEK PSD
507014

PLATE III-I-2

HILTON HEAD ISLAND
SOUTH CAROLINA

PUBLIC WATER
SUPPLY FACILITIES

3000 0 3000 6000
SCALE IN FEET

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

TABLE III-I-2

LIST OF WELLS - SEA PINES PSD[1]

Well No.	Location	Depth (feet)	Diameter (inches)	Yield (gpm)
1	Calibogue Cay	200	4	90
2	Baynard Cove Road	200	12	1,000
3	Baynard Ruins	200	10	500
4	Calibogue Cay	210	12	500
5	Otter Road	200	12	1,000
6	Point Comfort Road	200	10	500
7	Main Office	200	10	500
8	Greenwood Drive	200	10	250
9	Lighthouse Road	200	8	250
10	Lighthouse Road	200	8	250

[1] Source: Sea Pines Public Service District

TABLE III-1-3
QUANTITY OF WATER SOLD
SEA PINES PUBLIC SERVICE DISTRICT-1978[1]

Month	Single-Family		Multi-Family		Commercial		Total	
	MG[2]	GPD[3]	MG[2]	GPD[3]	MG[2]	GPD[3]	MG[2]	GPD[3]
Jan	12.427	400,900	3.186	102,800	1.806	58,300	17.419	561,900
Feb	11.449	408,900	3.688	131,700	1.996	71,300	17,133	611,900
Mar	14.305	461,500	8.669	279,600	2.398	77,400	25.372	818,500
Apr	15.938	531,300	9.123	304,100	3.308	110,300	28.369	945,600
May	18.302	590,400	10.681	344,500	3.623	116,900	32.606	1,051,800
June	18.438	614,600	13.350	445,000	3.577	119,200	35.365	1,178,800
July	19.099	616,100	13.442	433,600	3.954	127,500	36.495	1,177,300
Aug	18.998	612,800	13.129	423,500	3.954	127,500	36.081	1,163,900
Sept	17.841	594,700	9.404	313,500	3.996	133,200	31.241	1,041,400
Oct	17.538	565,700	9.196	296,600	3.887	125,400	30.621	987,800
Nov	16.253	541,800	7.449	248,300	3.381	112,700	27.083	902,800
Dec	14.418	465,100	3.524	113,700	2.983	96,200	20.925	675,000
Total	195.006		104.841		38.863		338.710	
Average		534,300		287,200		106,500		928,000

---

[1] Reference: Thomas & Hutton Engineering Company, "Report of a Study of Wastewater Flows in Sea Pines - Forest Beach Public Service Districts, Hilton Head Island, South Carolina," May 1979.

[2] MG - Million gallons

[3] GPD- Gallons per day

Forest Beach PSD - The water system for the Forest Beach Public Service District is comprised of five wells and one two-million-gallon ground storage tank. All the wells are 12-inch-diameter wells, 200 feet deep. Three are rated at 250 gpm, while the remaining two are rated at 1,000 gpm. The locations of the wells and ground storage tank are shown on Plate III-I-2.

Hilton Head No. 1 PSD - Hilton Head Water Company was the utility until 1974, when it became part of the public service district. Hilton Head No. 1 PSD now owns all the water facilities; however, Hilton Head Water Company still acts as the operating agent for the PSD.

The water system is comprised of 11 wells and one elevated storage tank with a capacity of 300,000 gallons; however, only five wells are actually used. Table III-I-4 lists the wells and appropriate information. The facilities are located on Plate III-I-2.

Chlorination is the only treatment the water receives, and it is performed more to control the hydrogen sulfide (rotten egg) odor rather than for disinfection purposes.

Table III-I-5 shows the results of two chemical analyses of the ground water in the public water supply system. Except for barium in the August 1978 sample, the ground water meets the primary and secondary regulations of the Safe Drinking Water Act, Public Law 93-523.

TABLE III-I-4

LIST OF WELLS - HILTON HEAD NO. 1 PSD[1]

Well No.	Diameter (inches)	Depth (feet)	Casing Depth (feet)	Capacity (gpm)	Remarks
1	6	200	135	200	
2	4	210	125	100	
3	4	200	125	100	
4	3	200	110	60	Abandoned
5	4	200±	125	80	
6	6	200±	140	250	
7	3	135±	80	15-20	Abandoned
8	6	220	135	200	
9	6	NA	NA	240	Not in Use
10	NA	NA	NA	100	
11	12	250	144	600	

---

[1] Source: B. P. Barber & Associates, Inc., Columbia, South Carolina

TABLE III-I-5
CHEMICAL ANALYSIS-PUBLIC WATER SUPPLY SYSTEM[1]
HILTON HEAD NO. 1 PSD

Parameter	Date of Sample 8-14-78	 9-13-78	Drinking Water Standards[2] (MCL's)
pH		7.6	6.5 - 8.5*
Chlorides	70		250*
Sulfate			250*
Flouride	0.4		1.6
Nitrate(as N)	0.02		10
Total Alkalinity (as $CaCO_3$)		170	-
Total Dissolved Solids			500*
Color (color units)		5	15*
Arsenic	<0.01		0.05
Iron	0.2		0.3*
Barium	1.5		1.0
Lead	<0.05		0.05
Cadmium	<0.010		0.010
Mercury	0.0002		0.002
Chromium	<0.05		0.05
Selenium	<0.01		0.01
Copper	<0.1		1.0*
Zinc	<0.1		5.0*
Manganese	<0.05		0.05*
Silver	<0.05		0.05

---

[1] All values in mg/l, except for pH and color

[2] Limits from NationalInterim Primary Drinking Water Regulations and National Secondary Drinking Water Regulations (denoted by asterisk), as provided by the Safe Drinking Water Act.

Monthly bacteriological monitoring reports sent to DHEC consistently show the number of coliform bacteria less than 1 per 100 ml as the arithmetic mean of all samples, using the membrane filter technique.

Broad Creek PSD - The Broad Creek Public Service District serves all residents of Palmetto Dunes Resort with potable water supplied by two deep wells into the principal artesian aquifer. The wells are both 8 inches in diameter and rated at 200 gpm. The PSD also has a 500,000-gallon elevated storage tank located just east of U. S. Route 278 at the plantation entrance. All facilities are located on Plate III-I-2.

Hilton Head Plantation Utilities Corporation - Hilton Head Plantation Utilities Corporation is a private company that owns and operates three separate systems on the island: Hilton Head Plantation, Northside Trailer Park, and the Hilton Head Hospital system.

The Hilton Head Plantation system consists of three 12-inch wells which are some 200 feet deep into the principal artesian aquifer. Two of the wells have 1,000-gpm pumps and 10,000-gallon pneumatic tanks for pumping into the water distribution system. These wells are located at the intersection of Seabrook Drive and Dolphin Head Drive (Well No. 1) and near Seabrook Farm (Well No. 3). Hilton Head Plantation is now constructing a 500,000-gallon elevated storage tank adjacent to Well No. 3 in order to maintain a favorable fire insurance rating.

The third well (Well No. 2), located at Whooping Crane Way and High Bluff Road, is presently capped and is not in use. This third well is capable of yielding 1,000 gpm.

The Northside Trailer Park system consists of one 10-inch well (Well No. 4) rated at 500 gpm. The Hilton Head Hospital system consists of one well rated at 1,000 gpm. This well currently serves only the hospital. The locations of these three systems are shown on Plate III-I-2.

On June 1, 1978, Hilton Head Plantation consisted of 1,229 platted and permitted lots and 91 multi-family dwelling units. Ultimately the Plantation is master-planned for 6,000 dwelling units. Based on a projected development schedule, Thomas & Hutton Engineering Company, consultants for Hilton Head Plantation, estimated that the average-day water demand would reach 2.5 mgd in 2010. The projections were disaggregated into residential and commercial categories and are shown in Table III-I-6.

In order to meet these projected water demands and maintain a favorable fire insurance rating, the following improvements have been proposed:

1. Connecting the existing wells at the hospital and the trailer park to the Plantation's main distribution system.

TABLE III-1-6
ESTIMATED FUTURE WATER DEMANDS - HILTON HEAD PLANTATION[1]

Year[2]	Completed Dwelling Units	Population[3]	Daily Domestic Demand[4] (1,000 gpd)	Daily Commercial Demand (1,000 gpd)	Total Average Daily Demand (1,000 gpd)	Maximum Instantaneous Demand (gpm)	Maximum Instantaneous Demand Duration (hrs.)
1979	264	845	105.6	32	137.6	1,240	3
1980	410	1,312	164	32	196	1,340	3
1982	710	2,272	284	36	320	1,560	3
1984	1,010	3,232	404	54	458	1,640	3
1986	1,310	4,192	524	72	596	2,725	4
1988	1,610	5,152	648	72	712	2,750	4
1990	1,910	6,112	764	90	854	2,885	4
1992	2,210	7,072	884	108	992	3,035	4
1994	2,600	8,320	1,040	108	1,148	3,200	4
1996	3,100	9,920	1,240	108	1,348	5,400	4
1998	3,600	11,520	1,440	108	1,548	5,610	4
2000	4,100	13,120	1,640	108	1,748	5,825	4
2002	4,600	14,720	1,840	108	1,948	6,025	4
2004	5,100	16,320	2,040	108	2,148	6,235	4
2006	5,500	17,600	2,200	108	2,308	6,400	4
2008	5,800	18,560	2,320	108	2,428	6,535	4
2010	6,000	19,200	2,400	108	2,508	6,610	4

---

[1] Reference: Thomas & Hutton Engineering Company, "Report on the Water Supply System - Hilton Head Plantation, Hilton Head Island, South Carolina," June 20, 1979.

[2] July 1 of each year.

[3] Dwelling units x 3.2 people per unit.

[4] Projected population x 125 gallons per capita per day.

2. Upgrade Well No. 4 at the trailer park to 750 gpm.

3. Install pump and pneumatic tank on Well No. 2 to yield 1,000 gpm.

4. Construct a 600,000-gallon elevated storage tank near the site of Well No. 2.

5. Construct a 2.5-mgd water treatment plant near Well No. 3 and additional ground storage ranging from 0.5 to 1.0 million gallons. This treatment plant will provide the flexibility of providing high quality water as, and if, the aquifer becomes increasingly contaminated by chlorides.

Hilton Head Utilities, Inc. - Hilton Head Utilities, Inc., is a private enterprise and a subsidiary of Hilton Head Water Company. This corporation owns and operates three public water systems on the island: Hilton Head Island Utility 1, Hilton Head Island Utility 2, and Hilton Head Island Utility 3.

The Hilton Head Island Utility 1 system serves Blue Heron Point Subdivision and the Mariner's Cove Club complex. The system consists of one 4-inch well rated at 100 gpm, one 6-inch well rated at 225 gpm, and 6,000 gallons of storage. The wells are some 225 feet deep into the principal artesian aquifer, cased to 125 feet.

The Hilton Head Island Utility 2 system serves Spanish Wells Plantation with three wells and 9,000 gallons of pressure tank storage. Two wells are 6-inch, rated at 225 gpm, and the third well is a 4-inch well rated at 400 gpm. All wells are 200-225 feet deep into the principal artesian aquifer.

The Hilton Head Island Utility 3 system consists of one 4-inch well, rated at 80 gpm. This system is located along Burkes Beach Road, adjacent the ocean.

Hilton Head Utilities, Inc., currently services about 110 connection with all three systems.

Deep Well Project - The Deep Well Project is an organization created in 1970 by Charlotte Heinrichs, a former nurse with the State Health Department. The primary concern of the project is to protect the health and sanitation of island homes.

When the project began, Beaufort County was the center of national attention because approximately 95 percent of the Black children were infested with worms, malnutrition, and lack of sanitation. Many had no running water nor inside plumbing. Water was drawn from shallow wells which were sometimes impure because the wells were too shallow, improperly constructed, and contaminated from failing septic systems. The Deep Well Project seeks to provide underprivileged islanders with means to acquire necessities such as septic tanks, deep wells, and inside plumbing.

Until 1972 it was a part of First Presbyterian Church. Although still aided by First Presbyterian and other churches, the Deep Well Project became a non-profit incorporation in 1972. It is governed by a board of trustees and operates on donations and money which constantly comes into the project from those who are repaying loans.

The Deep Well Project has funded 89 deep wells so far for island residents. They are essentially single-family wells, but most are used by two to four households on heir's property. Down payments are encouraged, and recipients are allowed to repay the loans as they are able. There are no written contracts with any recipients, and yet the Deep Well Project has a 95-96 percent payback rate.

A unique achievement for the Deep Well Project has been the installation of cluster wells, or wells which serve entire communities. Hilton Head Island is reputedly the first place in the nation to use the cluster well concept. The advantage of a cluster well is that it helps solve the problems created by heir's property because recipient households can get water without owning the land where the well is located.

Three cluster wells have been installed to date, and plans for another one are currently bineg reviewed by DHEC.

In the Muddy Creek area, a cluster well serves 22 households. At Baygall, a cluster well beside Barker Field serves 18 households, and one on Spanish Wells Road serves seven households.

All three are 4-inch, submersible wells, about 140 feet deep and properly encased to prevent saltwater contamination. They were all pump tested at 150 gpm; however, 50-60 gpm pumps were installed. All three have 525-gallon storage tanks at the well. These three cluster well distribution systems are not really expandable because the largest line size is 4-inch-diameter. These cluster well systems are located on Plate III-I-2.

A fourth cluster well is planned along U. S. 278 near Squire Pope Road and will serve about 20 households in the Stoney area. DHEC is currently reviewing the design. The well will be a 6-inch well, and the system is designed to accommodate expansion.

The cluster wells are maintained and administered by the Beaufort-Jasper Water Authority, monitored by SCDHEC, and paid for by the users.

Squire's Cte Subdivision - This new subdivision, located adjacent to Hilton Head Plantation along Squire Pope Road, will be served by a 6-inch submersible well. The well is 140 feet deep, backgrouted, and was pumped out at 25 gpm, although a 100-gpm pump was installed. There is a 3,000-gallon storage tank at the well. Currently 49 lots are connected to the system. The well was approved for operation by DHEC in January 1980.

Otter Hole Trailer Park - This water system is privately-owned, and consists of four wells serving 27 connections. There are two 4-inch wells and two 3-inch wells, although one 4-inch well is presently capped. Three are approximately 81 feet deep and one is 200 feet deep. Storage is provided by a 100-gallon tank, a 300-gallon tank, and a 525-gallon tank.

Other Public Water Supply Systems - These systems consist of those smaller individually-owned systems that serve the mobile homes and trailer parks that are scattered in small clusters in the rural areas of the northern half of the island, a few businesses (restaurants), and roadside rests. These systems are permitted by DHEC and identified in Table III-I-1.

Rural-Domestic Water Supply - Those people on the island not served by a public water supply system depend upon privately, individually-owned wells for water. Primarily, these are the small clusters of rural single-family homes in the Black communities of Baygall, Squire Pope, Marshland, Spanish Wells, Gardner, Otter Hole, and Singleton Beach. Many of these homes are now using deep wells into the principal artesian aquifer as a result of the Deep Well Project.

In 1978, the Beaufort-Jasper Comprehensive Health Services, Inc.

conducted a water survey of the Black community on Hilton Head Island. Some 218 homes and businesses were surveyed regarding their water source and whether they were interested in public water service. The results of this survey are shown in Table III-I-7. About 86 percent of those responding use a drilled well, while another 11 percent of those responding get water from a community well. One home along Marshland Road still hauled water. When asked whether they were interested in public water service, 202 responded "yes", 10 said "no", and 7 were undecided.

FUTURE WATER SUPPLY SOURCES AND PUBLIC SERVICES

In an effort not to add to the conflict between the golfer's demands for more golf courses, and consequently more irrigation water, and with the discussion of declaring the area a capacity use area, Hilton Head Plantation Company elected in late 1979 to drill some 2,800 feet down to an aquifer called the Black Creek Sands. The Black Creek Formation and aquifer were discussed in Chapters II-E and II-H. This aquifer is considerably deeper than the principal artesian aquifer which supplies the high quality water for potable usage on the island.

This well has been pump-tested at 1,000 gpm, but to be on the safe side and prevent saltwater intrusion the SCWRC is recommending that the golf course only pump 500 gpm.

Quality sampling showed chlorides around 540-570 mg/l. This exceeds the Secondary Maximum Contaminant Level of 250 mg/l for public

TABLE III-I-7

BEAUFORT-JASPER COMPREHENSIVE HEALTH SERVICES, INC.

1978 WATER SURVEY IN BLACK COMMUNITY(a)

Area	No. of Homes Surveyed	No. of Businesses Surveyed	House	Trailer	No. in Household	Number of Households or Businesses Currently						Interested in Water Service		
						Drilled Well	Well Handpump	Shallow Well	Open Well	Community Well	Haul Water	Yes	No	Undecided
Marshland Road	32	4	18	14	121	31	0	0	1	2	1	35	1	0
Along US 278	22	4	19	3	96	23	0	0	0	0	0	23	0	1
[illegible] Creek Rd.	14	0	5	9	63	3	0	0	0	11	0	13	1	0
Squire Pope Rd.	22	0	18	4	93	21	0	1	0	0	0	19(b)	1(b)	3
Gumtree Road	14	1	10	4	63	15	0	0	0	0	0	14	0	1
Spanish Wells Rd.	24	2	17	7	77	24	0	0	0	0	0	23	2	1
Wild Horse Road	16	0	12	4	57	15	0	0	0	0	0	16	0	0
Jonesville Road	11	0	10	1	35	9	0	0	0	0	0	9	2	0
Burkes Beach Rd.	8	0	8	0	29	4	0	0	0	4	0	8	0	0
Dillon Road	9	0	4	5	29	5	0	1	0	0	0	7	1	1
Bradley Beach Rd.	5	0	4	1	14	3	0	2	0	0	0	5	0	0
[illegible] Place	3	0	1	2	12	3	0	0	0	0	0	3	0	0
[illegible] Place	3	0	2	1	10	3	0	0	0	0	0	3	0	0
Singleton Beach Rd.	3	0	3	0	4	3	0	0	0	0	0	3	0	0
[illegible] Club Rd.	1	0	1	0	6	1	0	0	0	0	0	1	0	0
[illegible] Road	3	0	2	1	9	2	0	0	0	1	0	3	0	0
[illegible] Road	4	0	2	2	16	0	0	0	0	4	0	4	0	0
Wild Horse Lane	2	0	0	2	7	2	0	0	0	0	0	2	0	0
[illegible] Road	1	0	1	0	4	1	0	0	0	0	0	1	0	0
[illegible]	4	0	4	0	8	3	0	0	0	0	0	3	1	0
O'Connor Road	1	0	1	0	2	1	0	0	0	0	0	0	1	0
Murray Avenue	1	0	0	1	2	1	0	0	0	0	0	1	0	0
[illegible] Subdiv.	1	0	1	0	2	1	0	0	0	0	0	1	0	0
[illegible] Road	1	0	1	0	4	0	0	0	0	0	0	1	0	0
[illegible] Street	1	0	1	0	2	0	0	0	0	0	0	1	0	0
[illegible] Camp Road	1	0	1	0	3	0	0	0	0	0	0	1	0	0
Mitchelville Rd.	1	0	1	0	1	0	1	0	0	0	0	1	0	0
Fish Haul Road	1	0	1	0	3	1	0	0	0	0	0	1	0	0
TOTAL:	208(c)	11(c)	148	61	770	175	1	4	1	22	1	202	10	7

(a) Numbers may not add to total because of less than 100 percent responding to all questions.
(b) One household responded "Yes" to water service for fire hydrants, but "No" to water service for consumption.
(c) Two (2) homes were also listed as businesses and are tallied in both categories.

drinking water systems; however, it is of sufficient quality for golf course irrigation water.

Hilton Head Plantation Company will pump the ground water into a lagoon storage system and use the additional water for their Bear Creek Golf Course, scheduled to open in spring, 1980.

In January 1980, the Beaufort-Jasper Joint Planning Commission, working at the request of the Beaufort-Jasper Water Authority, submitted application for a $60,000 federal grant under the Coastal Energy Impact Program to study the feasibility of constructing an open channel canal to run parallel with the present surface canal that brings water from the Savannah River to the authority's 8-mgd water treatment plant at Chelsea near the Chechessee River. The application states that due to the lowering of the principal artesian aquifer in the Beaufort-Jasper Counties area causing increasing amounts of saltwater intrusion, there needs to be a comprehensive research investigating a future water source for Hilton Head Island that will be available continually in self-replenishing quantities. The application states that "...the goal is to develop and implement an option highlighting a non-depletable water source. An Alternative which lessens Hilton Head Island's dependency on the principal artesian aquifer subsequently takes the island out of competition for scarce groundwater with new energy facilities in the Savannah and Jasper County area."

Another possibility that would be investigated with the grant money is the feasibility of a 10 - 15 mgd well field in the Victoria Bluff area to serve Hilton Head Island for 5 - 15 years. Pipelines would be built across the Calibogue Sound to convey this ground water to the island. Should ground water ever be replaced by the Savannah River option, the pipelines would already be in place.

The proposal and grant-application were subsequently denied in January, 1980.

The Beaufort-Jasper Water Authority currently supplies about 5 mgd of treated Savannah River water to the military installations in Beaufort, the residents of the Beaufort-Port Royal area, and some of the residents of Lady's Island. In 1976, the SCWRC reports that approximately 1,800 million gallons of surface water from the Savannah River were used in Beaufort County. This represents about 27 percent of the total water use (6,600 million gallons) in Beaufort County in 1976.

Preliminary engineering plans for a rural water district on Hilton Head Island were presented by Freiesleben - Yerkes, Inc., to an Ad Hoc group on April 16, 1980. The Ad Hoc group is comprised of representatives from the Beaufort-Jasper Comprehensive Health Services, Inc., the Beaufort-Jasper Water Authority, the Hilton Head Island Deep Well Project, and the Hilton Head Island Fire District.

The proposal is to create a water district, similar to a PSD, and would include Jenkins Island, the Gardner-Matthews area, the Chaplin

Community, and the Baygall and Mitchellville areas.

The drive to provide a water district in the rural areas originated with the local fire departments which felt that water lines would provide better fire protection and would reduce fire insurance rates on the north end.

The comprehensive study addresses the water requirements for all the non-PSD areas that are not served by public water supply systems, and the need for an off-island source to replace the principal artesian aquifer.

The group intends to petition Beaufort County Council for the creation of a rural water district once all the plans are finalized.

CHAPTER III-J

WASTEWATER PROGRAMS

Wastewater collection and treatment for the island is principally provided by designated public service districts (PSD's), which have been established by enabling state legislation. There are four public service districts on the island. These PSD's are listed below.

- Sea Pines Public Service District
- Forest Beach Public Service District
- Broad Creek Public Service District
- Hilton Head No. 1 Public Service District

Each public service district operates its own wastewater treatment and disposal facilities, with the exception of the Forest Beach Public Service District. Wastewater is conveyed from Forest Beach to the Sea Pines Public Service District for treatment and disposal.

Hilton Head Plantation is served by treatment facilities owned and operated by the Hilton Head Plantation Utilities Corporation. Several small, privately-owned treatment facilities are located elsewhere on the island which provide service to isolated residential or resort areas.

These include the Mariner's Cove plant, the Northside Trailer Park plant, and the Port Royal Inn plant which lies within the boundaries of the Hilton Head No. 1 Public Service District.

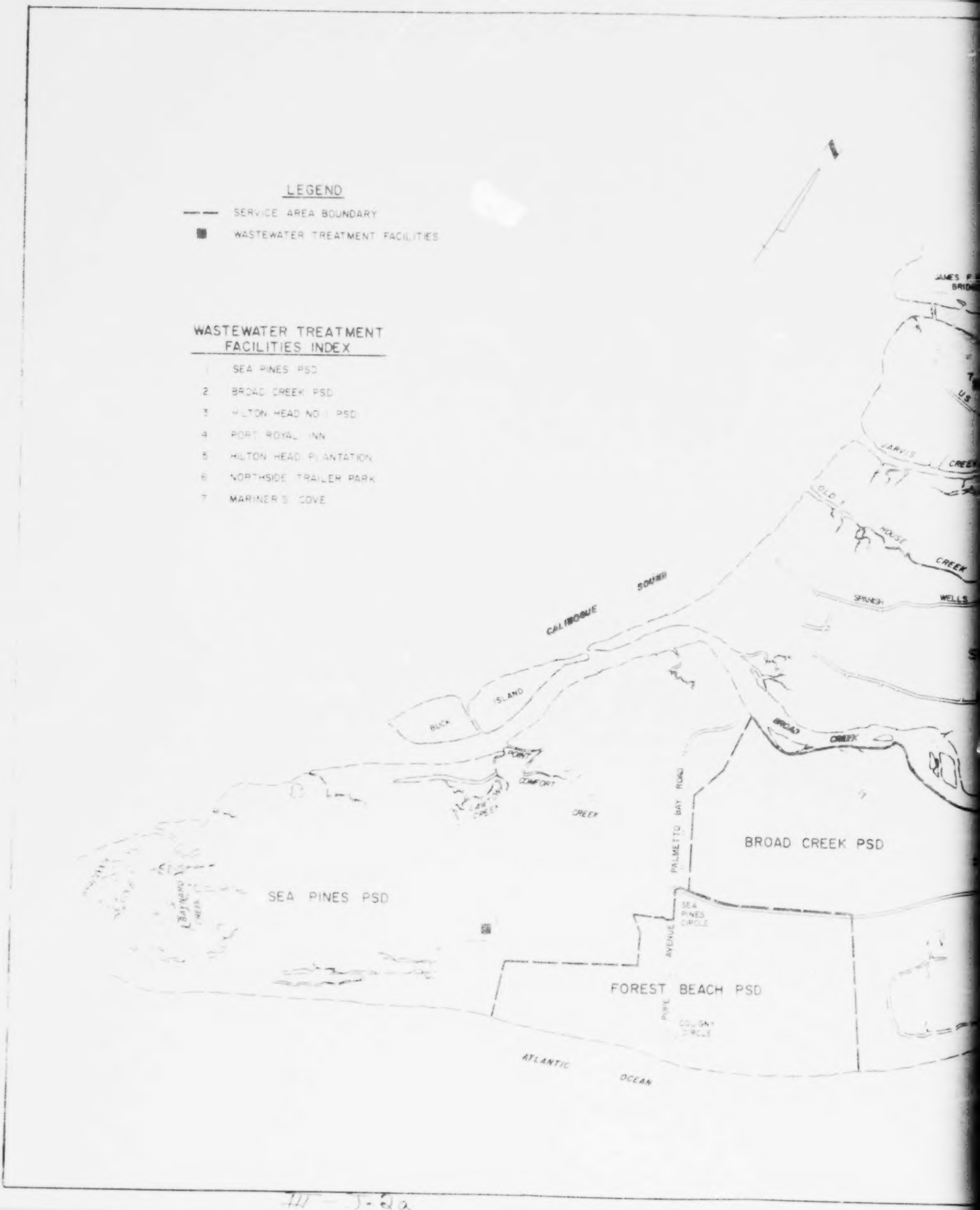
Plate III-J-1 indicates the location of these treatment facilities and delineates their respective service areas. Boundaries of each PSD are also noted. Each treatment facility is discussed in the following sections. More detail is provided for the Sea Pines PSD plant, in light of its size and existing discharge to Lawton Canal.

SEA PINES PSD PLANT

The Sea Pines PSD treatment plant is owned and operated by the Sea Pines Public Service District Commission. The plant treats wastewater generated from the Sea Pines PSD and the Forest Beach PSD. The plant is now being expanded to provide a capacity of 2.5 million gallons per day (mgd). This capacity is allocated 50 percent to Sea Pines and 50 percent to Forest Beach (1.25 mgd apiece).

Background

The first increment of the Sea Pines plant was constructed in 1969; a total treatment capacity of 0.2 mgd was provided by two 0.1 mgd package contact stabilization units. The plant was expanded to 0.8 mgd in 1972 when a 0.6 mgd complete mix activated sludge unit was constructed.


LEGEND
SERVICE AREA BOUNDARY
WASTEWATER TREATMENT FACILITIES
WASTEWATER TREATMENT FACILITIES INDEX
1 SEA PINES PSD
2 BROAD CREEK PSD
3 HILTON HEAD NO 1 PSD
4 PORT ROYAL INN
5 HILTON HEAD PLANTATION
6 NORTHSIDE TRAILER PARK
7 MARINER'S COVE
JAMES F. BYRNES BRIDGE
JARVIS CREEK
OLD HOUSE CREEK
SPANISH WELLS
CALIBOGUE SOUND
BUCK ISLAND
BROAD CREEK
POINT COMFORT CREEK
LAWTON CREEK
BAYNARD CREEK
PALMETTO BAY ROAD
BROAD CREEK PSD
SEA PINES PSD
SEA PINES CIRCLE
AVENUE
FOREST BEACH PSD
POPE
COLIGNY CIRCLE
ATLANTIC OCEAN

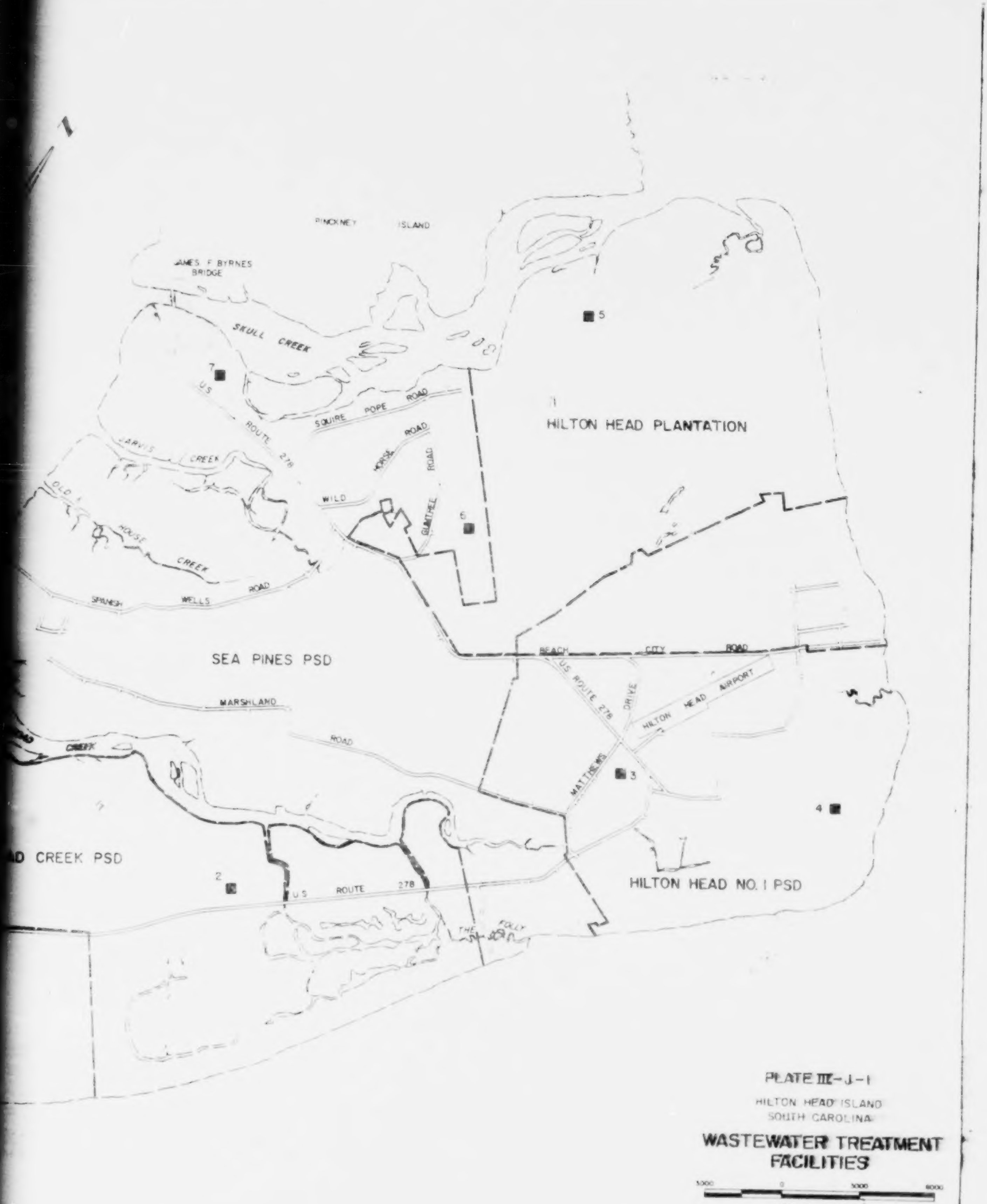

PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
SQUIRE POPE ROAD
US ROUTE 278
JARVIS CREEK
OLD HOUSE CREEK
WILD HORSE ROAD
GUMTREE ROAD
SPANISH WELLS ROAD
HILTON HEAD PLANTATION
SEA PINES PSD
BEACH CITY ROAD
US ROUTE 278
DRIVE
HILTON HEAD AIRPORT
MARSHLAND ROAD
MATTHEWS
CREEK
AD CREEK PSD
US ROUTE 278
THE FOLLY
HILTON HEAD NO. 1 PSD
1
2
3
4
5
6
7
5000
0
5000
10000
SCALE IN FEET

PLATE III-J-1

HILTON HEAD ISLAND
SOUTH CAROLINA

WASTEWATER TREATMENT FACILITIES

US ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

]

Another 0.6 mgd complete mix unit was added in 1974 which increased the total plant capacity to 1.4 mgd. In 1975, a flow equalization basin and aerated polishing pond were constructed to increase capacity to 2.0 mgd.

Treated effluent from the 2.0 mgd Sea Pines plant was to be disposed of by spray irrigation. Facilities were constructed to allow the spraying of treated wastewater effluent onto the Club Course in Sea Pines, the Shipyard Course, and portions of the Sea Pines Forest Preserve.

During July-August 1978, DHEC representatives noted during field inspections that only a portion of the treated effluent was being disposed of by spray irrigation; the remainder of treated effluent was being discharged into Lawton Canal because the total volume of treated wastewater exceeded the irrigation demands of the golf courses. In September 1978, DHEC issued a Consent Order to the Sea Pines Public Service District which set forth conditions under which the Sea Pines plant would be operated. These conditions are listed below.

1. Limit the daily maximum volume of discharge from the waste treatment facility to 2.0 mgd and minimize the volume of discharge to Lawton Canal by maximum utilization of available spray area.

2. On or before December 15, 1978, install a system of disinfection which will provide for compliance with the Total Coliform limitation in Item 5 below.

3. Until such time as Item 2 above has been completed, there shall be no additional loading (additional taps) introduced into the previously permitted collection systems.

4. On or before November 1, 1978, complete studies addressing malfunctioning collection lines or pump stations and any other areas where wastewater runoff occurs which may contribute to contamination of Lawton Creek. The study should also address repairs to any malfunctioning portions of the waste treatment facilities.

5. On or before December 15, 1978, meet the following effluent limitations.

PARAMETER	LIMIT	SAMPLING FREQUENCY
Flow	2.0 mgd	Continuous
BOD_5	30 mg/1 (monthly avg.)	1/week
TSS	30 mg/1 (monthly avg.)	1/week
Total Coliform	70/100 ml (monthly avg.)	Daily
Dissolved Oxygen	minimum of 5.0 mg/1	Daily

6. Laboratory analysis of the samples referred to in Item 5 above will be submitted to the Department of Health and Environmental Control, Attention: Enforcement Section, on a monthly basis with the first report due on January 15, 1979,

covering the period December 15, 1978, to December 31, 1978. Then monthly thereafter.

7. On or before December 1, 1978, correct any problems addressed in Item 4 above. If construction is required beyond the time period allotted, a schedule for correction of the problem may be recommended to the Department of Health and Environmental Control for inclusion in this Order.

8. Discharge under interim effluent conditions may continue until completion of a selected alternative for waste treatment. The selected alternative will be implemented in accordance with the following schedule:

a. Department of Health and Environmental Control will provide water quality assessment information establishing guidelines for future waste treatment needs.

b. Within 90 days of receipt of this guidance, Sea Pines Public Service District will submit an engineering report addressing alternatives for waste treatment.

c. Within 180 days of receipt of Department of Health and Environmental Control approval of an alternative, Sea Pines

Public Service District will submit plans and specifications for construction of the selected alternative and a recommended schedule for implementation. The resulting schedule will be made a part of this Order.

In accordance with Condition No. 8 of the Consent Order, the Sea Pines PSD submitted a Preliminary Engineering Report dated November 6, 1978, to DHEC. The report proposed that an immediate interim expansion of the Sea Pines plant be undertaken to provide a capacity of 2.5 mgd. By letter dated December 14, 1978, DHEC approved the concept of this expansion program and accordingly revised the terms of the original Consent Order. These revised conditions are noted below.

1. Paragraph 1 is deleted and the following substituted: Minimize the volume of discharge to Lawton Creek by maximum utilization of available spray areas and in no case discharge more than 2 mgd to Lawton Canal.

2. The flow limitation contained in paragraph 5 may be increased to 2.5 mgd in accordance with the concept contained in the "Preliminary Engineering Report, Sea Pines Public Service District Treatment Plant Expansion to 2.5 mgd", prepared by Thomas and Hutton Engineering Company, 20 Bay Street, East, Savannah, Georgia 31402, dated November 6, 1978.

3. Paragraph 8 is deleted and the following substituted:

   8. The Sea Pines Public Service District will ensure that until adequate waste treatment facilities are completed, any discharge from the existing facility complies with the effluent limitations contained in Paragraph 5, as amended.

4. The following is added:

   9. The Sea Pines Public Service District will implement the approved alternative as contained in the modified 201 Waste Treatment Facilities Plan in accordance with the following schedule:

      a. On or before June 1, 1980, submit an Engineering Report detailing the concept for implementation of the approved waste treatment alternative; and,

      b. On or before February 1, 1980, submit Plans and Specifications for construction of facilities as outlined in the Engineering Report; and,

      c. Construct such facilities in accordance with a construction schedule which will be developed by the Department of Health and Environmental Control and which will be based on the complexity of required construction.

This schedule will become a part of this Order.

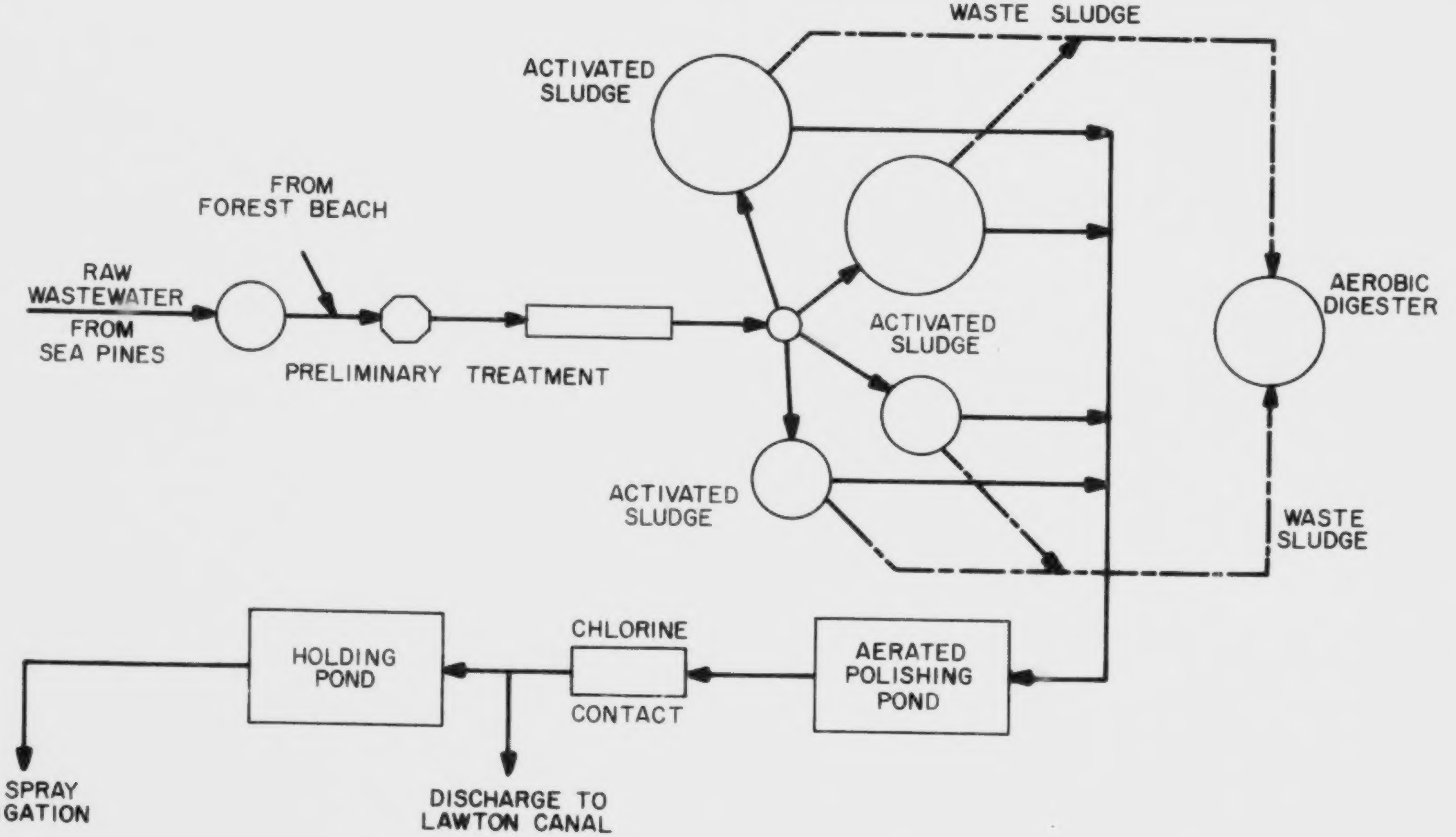
10. In the event that an Environmental Impact Statement is required by the Environmental Protection Agency, the above schedule will be revised to reflect any resulting delays.

As part of the interim construction program, the two existing 0.6 mgd complete mix activated sludge units are being converted to 1.15 mgd contact stabilization units by modifying the existing aerobic digester compartments of the complete mix units to reaeration basins for the contact stabilization mode. New sludge handling facilities will provide for flotation thickening of waste activated sludge followed by aerobic digestion. Liquid digested sludge will be land applied by a 1,600 gallon "Big A" application vehicle equipped with flotation tires.

Figure III-J-1 presents a schematic representation of the expanded 2.5 mgd Sea Pines plant. Start-up of expanded facilities is anticipated during 1980.

Wastewater Flows

Wastewater is conveyed to the Sea Pines plant through one of


WASTE SLUDGE
ACTIVATED SLUDGE
FROM FOREST BEACH
RAW WASTEWATER
FROM SEA PINES
PRELIMINARY TREATMENT
ACTIVATED SLUDGE
AEROBIC DIGESTER
ACTIVATED SLUDGE
WASTE SLUDGE
CHLORINE
HOLDING POND
CONTACT
AERATED POLISHING POND
TO SPRAY IRRIGATION
DISCHARGE TO LAWTON CANAL

FLOW DIAGRAM
SEA PINES PSD WTP

FIGURE III-J-1

three force mains. Two force mains convey wastewater from Sea Pines PSD to the plant from pumping stations #1 and #14. Wastewater from Forest Beach is pumped via a single force main to the Sea Pines plant. The flow from each of these force mains is measured by a magnetic flow meter. Table III-J-1 presents a summary of the recorded flows from Sea Pines and Forest Beach.

Because of the resort nature of Sea Pines and Forest Beach, wastewater flows exhibit a seasonal variation. As indicated by Table III-J-2, highest monthly average flows occur in July and August; lowest monthly average flows occur in January and February.

As previously indicated, a portion of the treated effluent from the Sea Pines plant is sprayed onto the Club golf course in Sea Pines, the Shipyard golf course, and a 10-acre area of the Forest Preserve. The remainder of the effluent is discharged into Lawton Canal. Table III-J-3 presents the quantities of effluent that have been sprayed onto each area and/or discharged to Lawton Canal.

A detailed study of the origin of wastewater flows from Sea Pines and Forest Beach was undertaken during February-May, 1979. The study involved the comparison of metered flows into the Sea Pines plant versus the flow calculated from pump running times and drawdowns at each of the three pump stations which pump directly to the plant. It was concluded that the meter on the Forest Beach force main measured approximately 77%

TABLE III-J-1

WASTEWATER FLOWS TO SEA PINES PLANT (1)

Month	From Sea Pines	From Forest Beach	Total
Jan. 1977	0.338	0.389	0.727
Feb.	0.300	0.324	0.624
Mar.	0.445	0.437	0.882
Apr.	0.502	0.487	0.989
May	0.463	0.344	0.807
June	0.674	0.443	1.117
July	0.889	0.537	1.426
Aug.	0.916	0.678	1.594
Sept.	0.667	0.472	1.139
Oct.	0.679	0.358	1.037
Nov.	0.647	0.307	0.954
Dec.	0.714	0.288	1.002
Jan. 1978	0.356	0.283	0.639
Feb.	0.356	0.280	0.636
Mar.	0.471	0.373	0.843
Apr.	0.398	0.391	0.789
May	0.642	0.382	1.024
June	0.684	0.439	1.123
July	1.012	0.498	1.510
Aug.	1.064	0.470	1.534
Sept.	0.702	0.394	1.096
Oct.	0.492	0.450	0.942
Nov.	0.437	0.402	0.839
Dec.	0.401	0.339	0.740
Jan. 1979	0.571	0.294	0.865
Feb.	0.500	0.311	0.811
Mar.	0.631	0.367	0.998
Apr.	0.752	0.434	1.186
May	0.795	0.447	1.242
June	1.009	0.586	1.595
July	0.867	0.764	1.631
Aug.	0.799	0.731	1.530
Sept.	0.593	0.527	1.120
Oct.	0.560	0.400	0.960
Nov.	0.533	0.354	0.887
Dec.			

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(1) Wastewater flows expressed in mgd.

TABLE III-J-2

COMPARISON OF MONTHLY AVERAGE FLOWS TO SEA PINES TREATMENT PLANT (1)

Month	1977	1978	1979
January	0.727 (46%)	0.639 (41%)	0.865 (53%)
February	0.624 (39%)	0.636 (41%)	0.811 (50%)
March	0.882 (55%)	0.843 (54%)	0.998 (61%)
April	0.989 (62%)	0.789 (51%)	1.186 (73%)
May	0.807 (51%)	1.024 (66%)	1.242 (76%)
June	1.117 (70%)	1.123 (72%)	1.595 (98%)
July	1.426 (89%)	1.510 (97%)	1.631 (100%)
August	1.594 (100%)	1.553 (100%)	1.530 (94%)
September	1.139 (71%)	1.096 (71%)	1.120 (59%)
October	1.037 (65%)	0.943 (61%)	0.960 (59%)
November	0.954 (60%)	0.839 (54%)	0.887 (54%)
December	1.002 (63%)	0.740 (48%)	

(1) Monthly average flows in mgd. Values in parenthesis are ratios of flow in that month to highest monthly average flow, expressed as a percentage.

TABLE III-J-3

DISPOSAL OF TREATED EFFLUENT
FROM SEA PINES PLANT (1)

Month	Flow to Plant MGD	Club Course 70ac		Shipyard Course 70ac		Forest Preserve 10 acre		Discharge to Canal MGD
		MGD	In/Wk	MGD	In/Wk	MGD	In/Wk	
Oct. 1977	1.037	.050	3/16"	.223	3/4"	.063	1-1/2"	.701
Nov. 1977	.954	.026	1/8"	.048	3/16"	.013	3/8"	.867
Dec. 1977	1.002	.001	0	.005	1/16"	.001	1/16"	.995
Jan. 1978	.639	0	0	.010	1/16"	.003	1/16"	.626
Feb. 1978	.636	0	0	.016	1/16"	.005	1/8"	.615
Mar. 1978	.843	.053	3/16"	.168	3/4"	.048	1-1/4"	.574
Apr. 1978	.789	.015	1/16"	.126	1/2"	.036	1"	.612
May 1978	1.024	.103	3/8"	.215	3/4"	.061	1-1/2"	.645
June 1978	1.123	.205	3/4"	.219	3/4"	.062	1-1/2"	.637
July 1978	1.510	.119	1/2"	.229	1"	.064	1-3/4"	1.098
Aug. 1978	1.553	.151	1/2"	.587	2"	.166	4"	.649
Sept. 1978	1.096	.164	5/8"	.116	1/2"	.033	7/8"	.703
Oct. 1978	.943	.189	3/4"	.071	1/4"	.019	1/2"	.664

(1) Taken from Preliminary Engineering Report dated November 6, 1978 prepared by Thomas and Hutton Engineering Co.

of the flow pumped to the plant and that approximately 270,000 gpd of unaccounted-for water was entering the Sea Pines system.

A program of televisual inspection and internal grouting of portions of the Sea Pines sewerage system was undertaken in order to detect sources of inflow/infiltration. This program was completed during June and July 1979, and approximately 200,000 gpd of extraneous flow eliminated.

Effluent Quality

In accordance with conditions of the DHEC Consent Order, the volume of effluent discharged to Lawton Canal and its quality have been monitored and reported by the Sea Pines PSD. Table III-J-4 presents a summary of effluent data. As indicated, the quality of the effluent discharged to Lawton Canal has been well within the requirements of the Consent Order.

Disinfection

Because Lawton Creek and Broad Creek (to which Lawton Canal flows) are classified as SA waters suitable for shellfishing, the DHEC Consent Order contains requirements for bacterial sampling and sets a limit on total coliforms per 100 ml of effluent discharged from the Sea Pines plant. As an additional condition, DHEC required modifications to the chlorination system at the plant to enhance the disinfection process.

TABLE III-J-4

SEA PINES PSD EFFLUENT DATA

	Flow, mgd (1)	BOD_5, mg/l	SusS, mg/l	Tot. Col./100 ml
Consent Order Limits	2.0	30	30	70
Jan. 1979	0.74	8.4	6.0	3.5 (2)
Feb.	0.72	7.2	6.8	2.5 (2)
Mar.	0.71	13.7	6.6	3.1 (2)
Apr.	0.98	18.7	6.0	3.1 (2)
May	0.85	18.0	4.8	4.2 (2)
June	-	-	-	-
July	1.63	18.6	14.0	41.6 (2)
Aug.	0.67	21.6	11.5	6.9 (2)
Sept.	1.07	15.6	17.5	12.8 (2)
Oct.	0.89	7.7	5.8	5.9 (2)
Nov.	0.68	17.3	11.8	4.5 (2)
Dec.	0.56	11.2	6.5	3.2 (2)

(1) Volume of discharge to Lawton Canal

(2) Geometric average

In accordance, a portion of the final holding pond at the Sea Pines plant was partitioned off to form a chlorine contact basin of 400,000 gallons. This provides a 3.8-hour detention time at a flow of 2.5 mgd. Analysis of reported data from the period of October 1978 through August 1979 indicates that only 14 of 268 bacterial samples exceeded the total coliform limit of 70 per 100 ml, using the MPN technique.

Overflows from Sewerage System

The DHEC Consent Order required an investigation of the Sea Pines PSD sewerage system to identify possible malfunctions or inadequacies. Eight overflow pipes were found in the Sea Pines system, which had been approved by DHEC at the time of their construction. This practice is now prohibited. Seven of the overflows were plugged by the PSD, with only the overflow from Pump Station #1 remaining because of the station's size.

In late August 1979, approximately 400,000 gallons of raw wastewater overflowed from the station, ultimately draining to Lawton Canal, due to a power mishap in which one phase of the three-phase power to the station was lost. Because the other two phases were not killed, the auxiliary power generator was not called upon. Electrical modifications have been made at the station to prevent the recurrence of this situation.

BROAD CREEK PSD TREATMENT PLANT

The Broad Creek PSD wastewater facilities serve the Palmetto

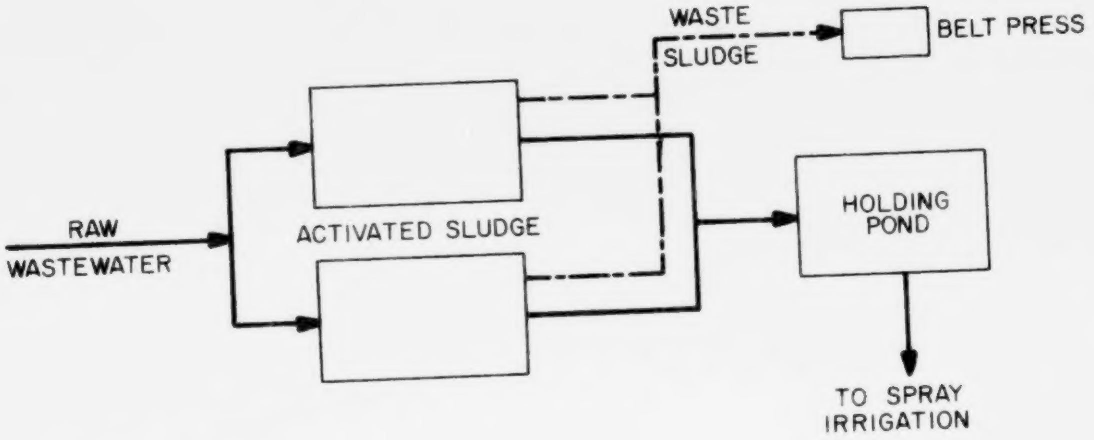
Dunes resort area. Wastewater is pumped to and treated at a 600,000 gpd secondary treatment plant. Treated effluent from the plant is disinfected and disposed of by spray irrigation. The current average wastewater flow to the plant is about 200,000 gpd; the peak monthly average during 1979 was approximately 350,000 gpd.

Description of Wastewater Facilities

Wastewater from Palmetto Dunes is pumped to the 600,000 gpd treatment plant. The treatment plant consists of two parallel 300,000 gpd extended aeration activated sludge units. Aeration is provided by mechnical rotors. Solids are settled in a final clarifier, and treated effluent chlorinated. Chlorinated effluent enters an approximately 7.5 million gallon holding pond prior to spray irrigation. Effluent is pumped from the holding pond, chlorinated again in-line, and conveyed to the spray irrigation areas. A schematic of the Broad Creek treatment facilities is presented in Figure III-J-2.

Description of Spray Areas

Treated wastewater from the Broad Creek PSD plant is sprayed onto two areas: either onto 18 holes of the Fazio golf course located within the Palmetto Dunes resort, or onto a 20-acre site located across Route 278 from the treatment plant. Manually-operated valves regulate the conveyance of wastewater to these sites.


WASTE
SLUDGE
BELT PRESS
RAW
WASTEWATER
ACTIVATED SLUDGE
HOLDING
POND
TO SPRAY
IRRIGATION

FLOW DIAGRAM
BROAD CREEK PSD WTP

FIGURE III-J-2

Of the 20 acres, approximately five are open field; the rest are wooded. Wastewater is sprayed via eight portable spray guns positioned in the area.

To date, the two spray areas have been sufficient to dispose of the treated wastewater from the Broad Creek PSD plant.

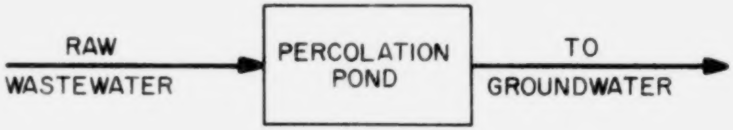
HILTON HEAD NO. 1 PSD WASTEWATER FACILITIES

The Hilton Head No. 1 PSD wastewater facilities primarily serve apartments, condominiums, and commercial establishments located within the boundaries of the PSD. All single-family residences (except two) are served by septic tanks.

Wastewater is pumped to a 225,000 gpd oxidation pond for treatment. Current flows average about 175,000 gpd. Due to the soils characteristics of the area, the pond acts as a percolation basin and has had no effluent discharge. Figure III-J-3 presents a schematic of the PSD treatment facilities.

Description of Existing Facilities

Wastewater is pumped to the Hilton Head No. 1 PSD treatment facilities, located between Matthews Drive and Route 278. The existing treatment facilities were constructed in 1971 and consist of an unlined


RAW
WASTEWATER
PERCOLATION
POND
TO
GROUNDWATER

FLOW DIAGRAM
HILTON HEAD NO.1 PSD WTP

FIGURE III-J-3

oxidation pond followed by two holding ponds. However, as previously noted, wastewater from the oxidation pond percolates radially into the groundwater. Because of this circumstance, there is concern regarding the possibility of groundwater contamination. As a result, DHEC placed a moratorium on additional connections to the system.

In order to assess the potential for groundwater contamination, wells have been installed to monitor groundwater quality. According to a DHEC report, analysis of samples taken from the observation wells suggests that groundwater contamination is occurring.

Future Wastewater Facilities

An 800,000 gpd wastewater treatment facility has been proposed for construction to meet the future needs of the Hilton Head No. 1 PSD. Construction is dependent upon the receipt of EPA grant monies and is anticipated to start soon. These new facilities will provide sufficient capacity to meet future needs, enable the abandonment of the existing plant serving the Port Royal Inn, provide adequate treatment of wastewater prior to disposal, and eliminate the potential for groundwater contamination. The plant is being designed for ultimate expansion to 1.18 mgd.

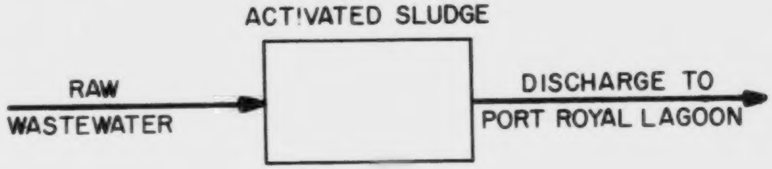
Treated effluent will be pumped from the plant, under Route 278, to Port Royal Plantation for spray irrigation onto the Barony and Robbers Row golf courses.

In order to provide additional capacity until such time as the 800,000 gpd Hilton Head No. 1 facilities become operational, private development interests have proposed to construct an interim 265,000 gpd treatment facility to supplement the PSD's existing oxidation pond. This plant would provide additional capacity and allow the construction of new residential units within the PSD. Effluent will be pumped to the Port Royal Plantation golf courses for disposal by spray irrigation. The interim facilities will be incorporated into the Hilton Head No. 1's 800,000 gpd plant.

On the basis of site investigations, DHEC has approved maximum spray rates for the wastewater irrigation of the Barony and Robbers Row courses. These rates allow approximately 550,000 gpd and 520,000 gpd for these courses respectively. However, the attainment of these rates can only be confirmed through actual experience.

PORT ROYAL INN PLANT

Wastewater from the Port Royal Inn is pumped to a 10,000 gpd package activated sludge treatment plant. Effluent from the plant is discharged into area surface waters. Concurrent with the construction of the new 800,000 gpd Hilton Head No. 1 PSD plant, a new pump station and force main will be built to replace the existing Port Royal Inn plant. Wastewater will be pumped to the new Hilton Head No. 1 plant for treatment and subsequent spray irrigation. Figure III-J-4 depicts the Port Royal treatment facilities.


ACT!VATED SLUDGE
RAW
WASTEWATER
DISCHARGE TO
PORT ROYAL LAGOON

FLOW DIAGRAM
PORT ROYAL INN WTP

FIGURE III-J-4

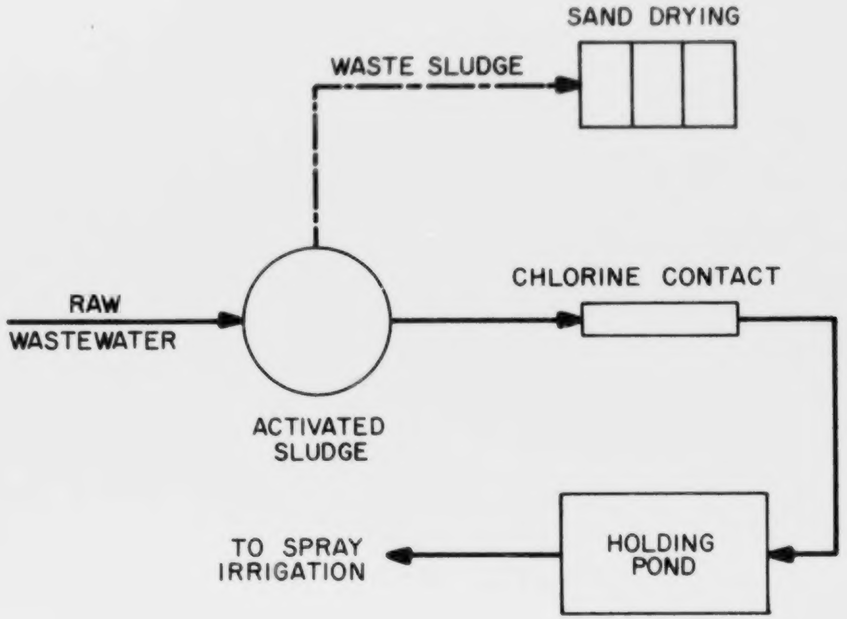
HILTON HEAD PLANTATION TREATMENT PLANT

The Hilton Head Plantation wastewater facilities serve developed property within the plantation boundaries, as well as the Hilton Head Hospital and the Hilton Head Elementary School. Wastewater is conveyed to and treated at a 0.5 mgd secondary treatment plant. Treated effluent from the plant is disinfected and disposed of by spray irrigation. Current wastewater flows to the plant average approximately 0.11 mgd.

Description of Wastewater Facilities

Wastewater from the Hilton Head Elementary School, the Hilton Head Hospital, and developed areas within Hilton Head Plantation is pumped to the 500,000 gpd wastewater treatment plant.

The treatment plant is an activated sludge package plant, now being operated in the extended aeration mode. Flexibility exists so that the plant can be operated in the contact stabilization mode. Treated effluent is chlorinated; chlorinated effluent then enters a five-million-gallon holding pond prior to spray irrigation. The holding pond provides a ten-day detention, based upon the plant's design capacity of 500,000 gpd. Waste activated sludge from the plant can be dewatered on sand drying beds. Figure III-J-5 depicts the Hilton Head Plantation wastewater facilities.


SAND DRYING
WASTE SLUDGE
RAW
WASTEWATER
ACTIVATED
SLUDGE
CHLORINE CONTACT
HOLDING
POND
TO SPRAY
IRRIGATION

FLOW DIAGRAM
HILTON HEAD PLANTATION WTP

FIGURE III-J-5

Description of Spray Area

The existing spray irrigation area consists of 53 acres and is located at the Seabrook Farm area near the plant. Treated effluent is sprayed via a portable spray gun onto open fields. A number of groundwater monitoring wells are located in the spray area: analyses of samples have indicated no adverse effects. Table III-J-5 presents a summary of analyses performed during 1978.

The Seabrook spray area is adequate to handle the existing quantity of wastewater; however, increased wastewater flows that will result from projected development within the plantation necessitate that additional spray areas be secured. Additional areas available for spray irrigation include the Polo Field and the Dolphin Head golf course.

A proposal to utilize the Dolphin Head golf course as a spray irrigation area for disposal of treated effluent is now under consideration by DHEC. The course is presently irrigated with potable water from the Ocala aquifer, at an average rate of 281,000 gpd (or about 0.85 inches per week). The peak application rate occurs in July and August at 1.63 inches per week; irrigation is least in January and February at about 0.22 inches per week. A primary concern of DHEC is the distance between ground level and the groundwater table. Normally, a minimum of five feet is desired. Water table depths of the golf course vary from two feet to greater than five feet.

TABLE III-J-5

HILTON HEAD PLANTATION
SUMMARY OF MONITORING DATA - REPORTED TO D.H.E.C. IN 1978 (1)

	Effluent	Well No. 2	Well No. 4	Well No. 6	Well No. 8	Acceptable Range
BOD_5						
Ave.	3.5	3.5	3.2	2.9	3.6	<10
Range	(2.4-6.0)	(2.2-4.8)	(1.6-6.4)	(1.7-4.8)	(1.4-8.8)	
D.O.						
Ave.	8.4	7.9	7.0	7.3	7.5	>0
Range	(7.0-9.5)	(6.0-8.7)	(5.4-8.4)	(6.3-8.6)	(6.5-8.4)	
pH						
Ave.	7.5	6.5	6.8	6.7	7.2	6.5-8.5
Range	(6.4-9.6)	(5.9-7.3)	(5.9-7.8)	(5.7-7.3)	(5.6-9.4)	
Chloride						
Ave.	31	35	79	39	152	<250
Range	(26-38)	(28-50)	(30-190)	(17-85)	(30-454)	
Sulfide						
Ave.	0.0002	0.05	0.005	0.002	0.004	<0.1
Range	(0.0-0.007)	(0.0-0.1)	(0-0.01)	(0.0-0.008)	(0-0.009)	
Sulfate						
Ave.	14.0	14.8	28	22	30	<250
Range	(8.5-23)	(8.7-30.0)	(17-60)	(15-34)	(11-45)	
Nitrate						
Ave.	0.02	0.008	0.007	0.009	0.04	
Range	(0.005-0.06)	(0.003-0.02)	(0.005-0.01)	(0.006-0.01)	(0.006-0.12)	Total less Than 5.0
Nitrate						
Ave.	0.94	1.1	0.7	1.0	1.3	
Range	(0.06-1.5)	(0.1-2.0)	(0.0-1.4)	(0.02-1.6)	(0.5-1.8)	
Solids						
Ave.	309	196	170	232	123	<500
Range	(40-560)	(40-360)	(8-431)	(132-400)	(40-165)	
Phosphorus						
Ave.	0.22	0.27	0.22	0.14	0.43	<0.5
Range	(0.07-0.34)	(0.07-0.37)	(0.03-0.41)	(0.03-0.20)	(0.17-0.87)	

(1) Date excerpted from Dolphin Head Golf Course Irrigation Engineering Report dated January 1979, prepared by Thomas & Hutton Engineering Company.

(2) All values except pH in mg/l.

MARINER'S COVE TREATMENT PLANT

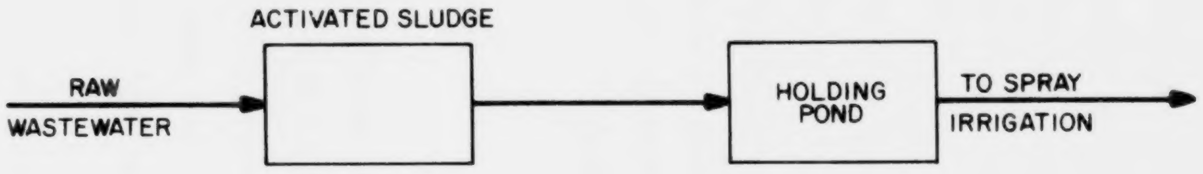
The Mariner's Cove plant provides treatment for the wastewater generated from forty units of the Mariner's Cove Club complex, which is located south of Route 278 near the bridge to Pinckney Island. Effluent from the plant is spray irrigated. The plant is owned by the Mariner's Cove Horizontal Property Regime.

In September 1979, it was discovered that raw or inadequately treated wastewater had been intermittently entering Skull Creek during the summer as a result of various system malfunctions. Limited sampling of shellfish waters did not indicate any contamination, most likely because of tidal dilution and heavy rainfall. Repairs have been made to the plant, and it is now operating properly.

Description of Facilities

The Mariner's Cove plant is a 20,000 gpd activated sludge package facility. Wastewater from Mariner's Cove is collected and pumped under Route 278 to the treatment plant. Treated effluent is chlorinated; it then flows into a holding pond from where it is pumped to the spray field. These wastewater facilities are shown schematically in Figure III-J-6.

Based upon an evaluation of system deficiencies, necessary repairs were performed as follows:


ACTIVATED SLUDGE
RAW
WASTEWATER
HOLDING
POND
TO SPRAY
IRRIGATION

FLOW DIAGRAM
MARINER'S COVE WTP

FIGURF

- Repairs were made to the pump station.

- The package plant was sandblasted and repainted. The blower and airlines have been repaired.

- Sludge piping and valving has been repaired or replaced.

- The electrical system was overhauled.

- Repairs were made to the chlorination system.

- The spray field was mowed.

Based upon recent inspections, the Mariner's Cove plant is now functioning properly.

Consideration is being given to the creation of a Public Service District, through appropriate legal mechanisms, to assume the provision of wastewater treatment and disposal for the Mariner's Cove complex. The exact boundaries that the PSD would encompass are uncertain.

NORTHSIDE TRAILER PARK PLANT

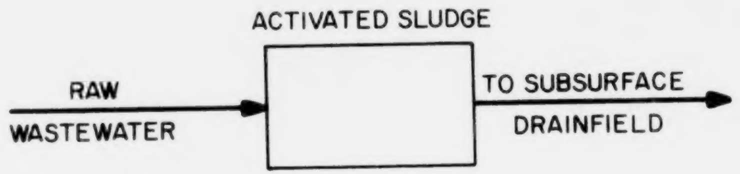
The Northside Trailer Park is located on the north end of Hilton Head, off Gumtree Road. Wastewater from the approximately forty units in the trailer park is treated in a 10,000 gpd extended aeration package plant. Treated effluent is chlorinated and discharged to a subsurface drainfield for disposal. Figure III-J-7 shows the trailer park system.

The operation of this plant will continue until adjacent areas of the Hilton Head Plantation are developed. At that time, the Northside treatment plant can be abandoned and flows conveyed into the Hilton Head Plantation sewerage system for treatment and disposal.

WASTEWATER SOLIDS DISPOSAL

For the most part, only small quantities of wastewater solids are generated by the wastewater treatment facilities on Hilton Head. This is attributed to the relatively low loadings to the plants, the operation of most of the plants in the extended aeration mode of the activated sludge process, or the use of oxidation ponds as the principal method of treatment (Hilton Head No. 1 PSD). Consequently, the amount of wastewater solids which must be handled and disposed is not yet a major consideration.

An exception exists at the Sea Pines - Forest Beach facility. Here, approximately 10,000 gallons of wastewater solids must be handled daily. Waste activated sludge solids are aerobically digested and then disposed of in liquid form. The digested solids are hauled via a flotation-tire tanker with a capacity of 1,600 gallons to a 13-acre application


ACTIVATED SLUDGE
RAW
WASTEWATER
TO SUBSURFACE
DRAINFIELD

FLOW DIAGRAM
NORTHSIDE TRAILER PARK WTP

FIGURE III-J-7

site located in the Forest Preserve approximately one mile from the plant. A demonstration project has been initiated by the Sea Pines PSD to investigate the effects of wastewater solids on the growth of turf grasses.

SEPTIC TANK SYSTEMS

For areas outside the existing PSD's and Hilton Head Plantation, the predominant means of wastewater disposal is the use of septic tank systems with the exception of areas which are already sewered such as Mariner's Cove and Northside Trailer Park. Currently there are no areas of Hilton Head Island which lie outside the PSD boundaries where septic tank malfunctions are known to occur on a regular basis. Plate III-J-2 indicates areas of Hilton Head that are served by septic tanks.

The DHEC Bureau of Environmental Sanitation routinely acts upon all septic tank applications for individual residences. Applications for larger systems greater than 1,500 gpd are reviewed by the Bureau of Wastewater and Stream Quality Control of DHEC.

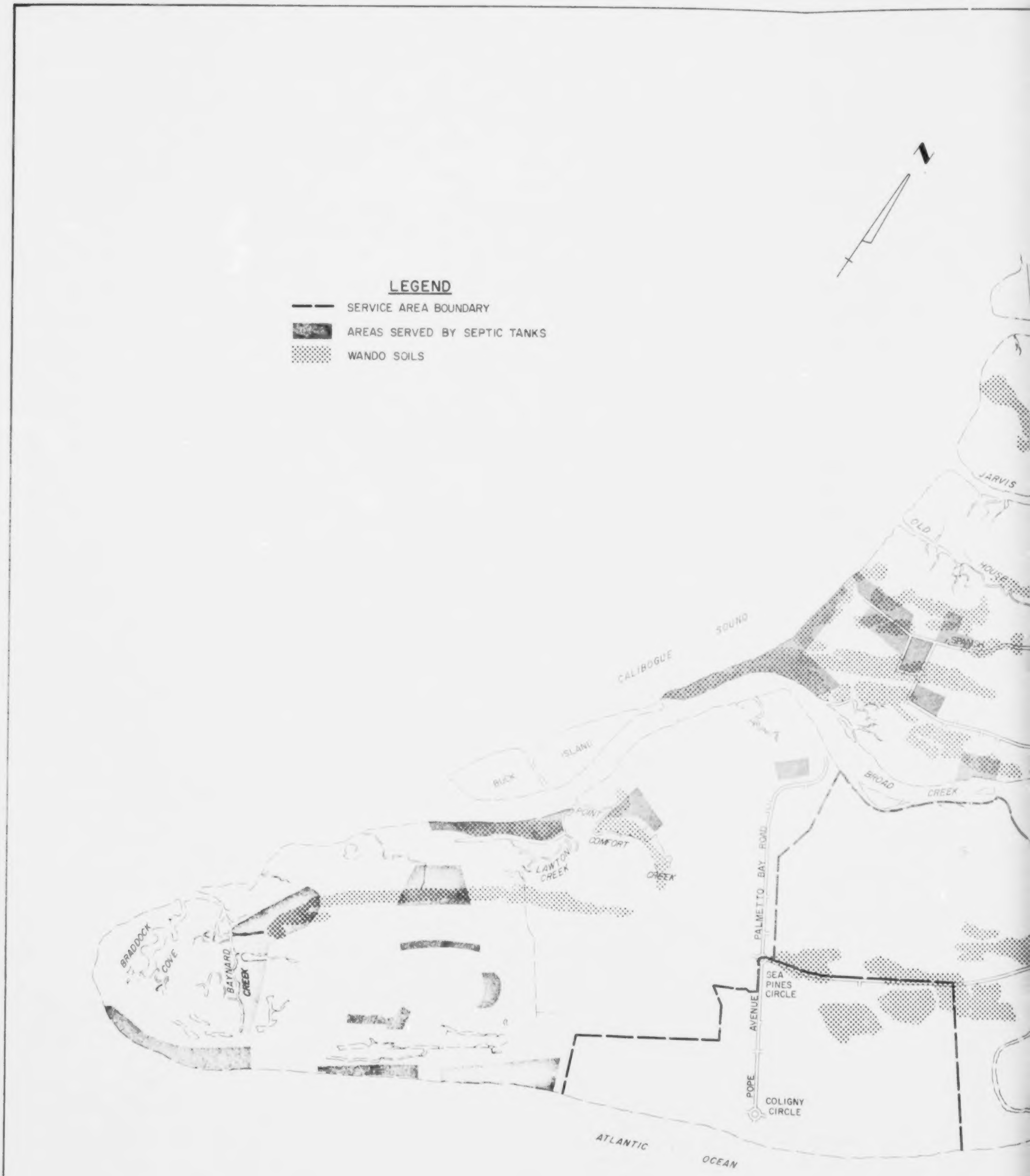
Site evaluations are conducted by DHEC for every site for which application has been made for installation of a septic system. Consideration is given to soil texture; depth to groundwater; and distances from wells, ditches, bodies of water, and property lines. The minimum depth to groundwater is 36 inches; modification of the site through grading and filling may be used to achieve this minimum separation on a case-by-case basis. Recommended minimum lot sizes are 12,500 square feet for homes served by a community water system and 30,000 square feet where water is provided by an on-site well.

Soil Suitabilities

The soils on Hilton Head Island are generally poorly drained, moderately permeable sands, loamy fine sands, and sandy loams. Fifteen general soils series have been identified on Hilton Head; these determinations have been made on-site by soil scientists of the Soil Conservation Service (SCS), U. S. Department of Agriculture.

Of the fifteen soil series, only the Wando Series has been given a "slight" classification by the SCS. (Other soil series have been given "severe" classifications primarily due to seasonally high groundwater.) A "slight" classification usually means that any soil limitations are minor and easily overcome and that septic tanks should work properly when adequately sized, correctly installed, and regularly maintained. Plate III-J-2 shows the location and extent of the Wando series on Hilton Head. As shown, there are large areas of the Wando series along Route 278 from approximately Palmetto Dunes to Sea Pines Circle, in the Matthews Drive - Port Royal area, between Route 278 and Marshland Road, and north and west of the Hilton Head Airport.

Although the Wando soils are most suitable for on-lot systems, other areas of the island may either be suitable for septic tank systems, or be made suitable by moderate site improvements such as grading or filling. Such areas, however, must be determined based upon a site survey on a lot-to-lot basis.


LEGEND
SERVICE AREA BOUNDARY
AREAS SERVED BY SEPTIC TANKS
WANDO SOILS
N
JARVIS
OLD
HOUSE
SPANISH
CALIBOGUE
SOUND
BUCK
ISLAND
BROAD
CREEK
POINT
COMFORT
CREEK
LAWTON
CREEK
BRADDOCK
COVE
BAYNARD
CREEK
PALMETTO BAY ROAD
SEA
PINES
CIRCLE
POPE
AVENUE
COLIGNY
CIRCLE
ATLANTIC
OCEAN

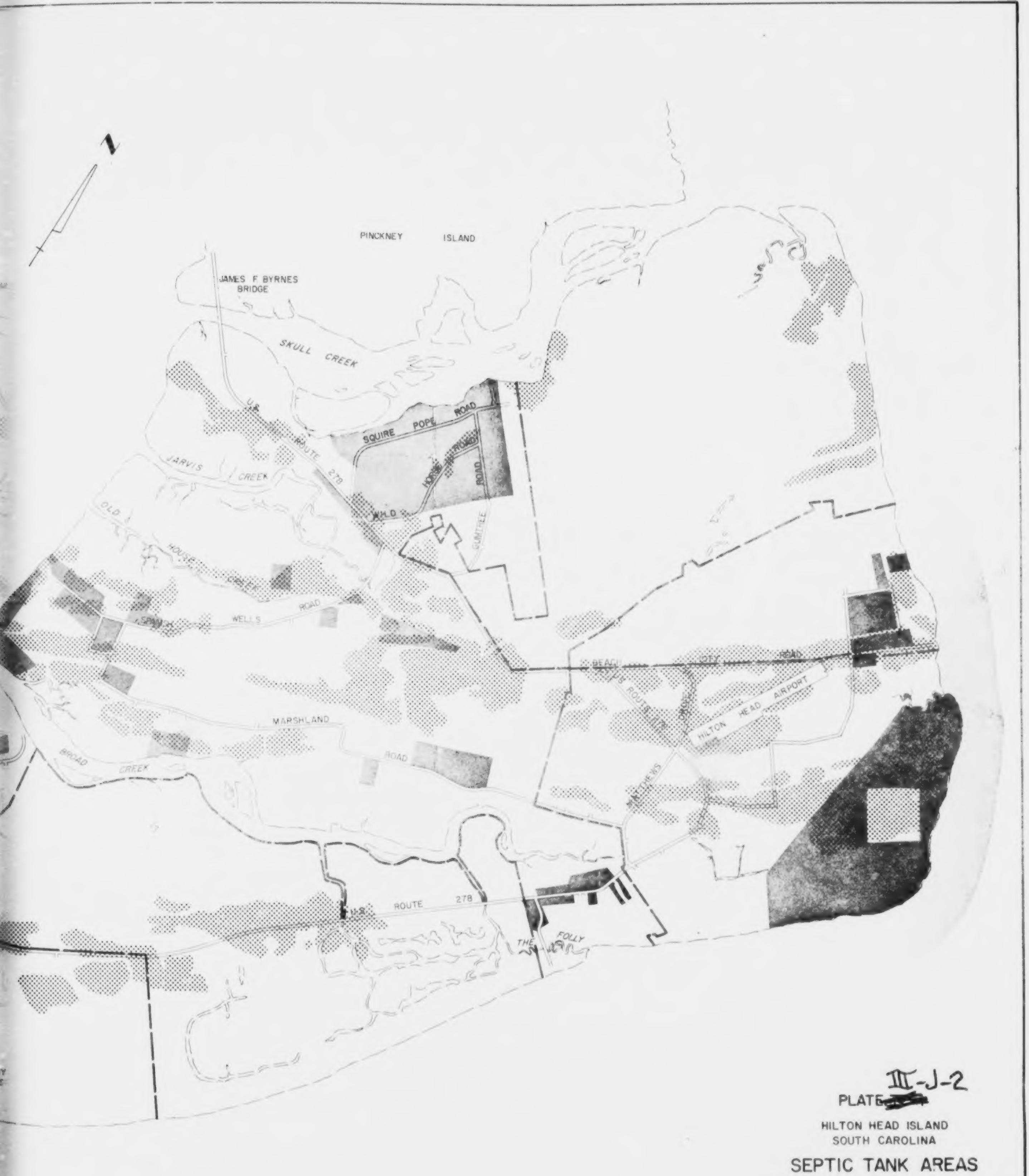

N
PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
U.S. ROUTE 278
SQUIRE POPE ROAD
HORSE ROAD
ROAD
W.H.D.
GUMTREE
JARVIS CREEK
OLD HOUSE CREEK
SPANISH WELLS ROAD
MARSHLAND ROAD
BROAD CREEK
BEACH CITY ROAD
U.S. ROUTE 278
MATTHEWS
HILTON HEAD AIRPORT
U.S. ROUTE 278
THE FOLLY

PLATE III-J-2

HILTON HEAD ISLAND
SOUTH CAROLINA

SEPTIC TANK AREAS

3000 0 3000 6000

SCALE IN FEET

US ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

III-J-28b

CHAPTER III-K-1

TRANSPORTATION

Hilton Head Island is accessible by several modes of transportation, which are described below.

ROADWAYS AND BRIDGES

Hilton Head is served by U. S. Route 278, which is the single link to the mainland. The highway runs down the center of the island from Byrnes Bridge to Sea Pines Circle, and provides access via State-designated roads, paved and unpaved local roads, and private roads to the plantation developments, rural communities, and commercial areas.

The most recent traffic counts available were taken in 1977. At that time, Route 278 was a two-lane road and operating well over its rated capacity of 5,800 vehicles per day as shown in Table III-K-1. In 1978, the State began a construction program to widen Route 278 to four lanes and increase its capacity. Construction is now nearing completion, and is expected to alleviate traffic congestion.

Citizens have suggested traffic studies at such intersections as the Hilton Head Elementary School entrance on U. S. 278, the post office

TABLE III-K-1

AVERAGE DAILY TRAFFIC COUNTS

Location	Average Daily Count
Near Sea Pines Circle	13,500 Annual Average
	16,300 Summer Season
Near Route 44	10,600 Annual Average
	12,800 Summer Season

Source: S. C. Highway Department, 1977.

entrance on Pope Avenue and the Folly Field Road intersection with U. S. 278. The study of pedestrian bridges and crosswalks in such congested areas as Singleton's Beach and Fairfield has also been suggested.

South Carolina Department of Highways and Public Transportation studies have shown pedestrian bridges and traffic control devices at the elementary school to be unwarranted at this time. Other intersections are to be studied for safety measures in 1980.

Other paved roads on the island are mainly either two-lane rural roads maintained by the County or private roads within the plantation and resorts maintained by developers or property owners associations. A number of unpaved roads serve individual dwellings or clusters of dwellings. Considerable dissatisfaction has been voiced over the quality of maintenance provided by the County Highway Department. The Island Government study reported that residents of Forest Beach and the northern Island communities who live on unpaved roads are very concerned about the apparent lack of county efforts to upgrade the roads and undertake any coordinated drainage program. They claim that some roads in these areas wash out completely with heavy rains and may be impassable for two or three days thereafter.

Two bridges along Route 278 provide access to the mainland. The Byrnes Bridge is a two-lane swing span structure over Skull Creek. The Mackay Creek Bridge is a fixed center span structure which connects to the mainland. Improvements to both bridges are either now underway or proposed, as described below.

A new four-lane bridge over Skull Creek will replace the existing two-lane swing span. Construction of approach spans for two of the four lanes is now underway; an additional contract has been let for construction of the main piers and superstructure for this span. The existing Byrnes Bridge will be removed as part of the project. It is anticipated that this work will be completed by mid-1982. Construction of a second parallel two-lane span over Skull Creek is dependent upon the availability of funds.

In conjunction with the Skull Creek project, a new two-lane bridge over Mackay Creek and widening of the present Mackay Creek bridge is proposed dependent upon the availability of funds. This work will be coordinated with plans for four-laning Route 278 on the mainland.

The completion of these bridge projects will greatly alleviate traffic congestion now caused by the opening of the Byrnes Bridge for the passage of watercraft.

AIR SERVICE

The island is served by the Hilton Head Airport, which is owned by Beaufort County. The airport is located off of Route 278, diagonally across from Pineland Mall. Commercial and general aviation services are provided.

Commuter airlines also link the island with nearby large population centers. Crown Airlines offers five flights daily to Savannah and hopes to add a route to Jacksonville. Atlantis Airlines offers five flights daily to Savannah and one to Myrtle Beach. Incoming flights include trips from Savannah, Charlotte, and Greensboro, N. C. They hope to offer flights to Charlotte soon. During the peak tourist season, Air South operates direct flights from Atlanta to Hilton Head Airport.

Improvements to the airport have recently been completed, consisting of added parking spaces, paving of taxiways and aprons, and fence erection. Two fixed base operators (FBO) are planning to expand their operations in the immediate future. Crown Airlines and Ginn Air Services are enlarging and renovating terminals, building hangars, adding equipment, and expanding services. The sale of a third FBO (Hilton Head Air Service) is now under review by the Federal Aviation Administration (FAA). Airport activity has steadily increased to the point where the need for a control tower on an annual or seasonal basis is under discussion by fixed base operators and the Aviation Board.

Local residents have voiced concern over the impacts of expanded airport operations. Noise pollution, stormwater runoff, and the growth inducing aspects of added capacity are subjects of public debate. The FAA has undertaken an airport noise abatement study in response to residents' concerns.

BUS SERVICE

The Beaufort-Jasper Regional Transportation Authority provides round-trip public bus service to Hilton Head from both Lobeco and Beaufort, on a fixed-route operation. This service primarily provides transportation to commuting workers. Both the Lobeco bus and the Beaufort bus make two round trips daily. Approximately 1,500 passengers are carried weekly.

The Beaufort-Jasper Comprehensive Health Services provides bus transportation to their health care facilities. This is a dial-a-ride type service for patients. The buses make 2-4 trips per day to Hilton Head and serve an estimated 50 riders per week.

Private developers provide limited transportation services for residents and employees. Sea Pines operates a mini-bus service for those employees who live in the Sea Pines Properties. In addition, five buses operate in a dial-a-ride fashion and are provided for residents and guests of Sea Pines who have destinations on Sea Pines Properties, Coligny Plaza and the Hilton Head Transportation Center on Route 278. These mini-buses carry between 75 and 300 people per day depending upon the season.

CHAPTER III-L

SOLID WASTE

Residential trash collection on the island is provided by door-to-door pickup in the private developments, while refuse collection boxes are used to serve the more rural portions of the island. Refuse from commercial establishments is disposed of under contract in on-site dumpsters which are then emptied. All collected refuse is hauled to landfills located off the island.

The door-to-door pickup service in the private developments is provided by Island Refuse, a subsidiary of Waste Management Corporation, and by Residential Refuse Corporation which initiated service on April 1, 1980. Both firms provide collection twice weekly. Residential Refuse's collection fee is $100 per year, while Island Refuse's rate has recently been raised to $144 per year. Island Refuse has proposed to abandon its door-to-door collection service in lieu of curb-side pickup using company-furnished 90-gallon containers with wheels. These containers would be mechanically emptied into the compactor truck, thereby reducing labor costs and increasing the number of containers that could be emptied during a day. Consequently, pickup monthly charges could be lowered to approximately $90 per year. To date, the various property owners associations and plantation development companies have not embraced the curbside pickup concept.

About 20 refuse collection boxes are scattered throughout the rural areas of the island. These containers are emptied twice weekly by Edisto Services, another subsidiary of Waste Management Corporation, under an existing two-year contract with Beaufort County. This number of containers is inadequate to handle the present quantity of refuse. In particular, the cluster of container boxes on Marshland Road is routinely filled beyond capacity. As a result, refuse is commonly strewn over the ground. Such conditions give rise to aesthetic (visual and odor), health, and non-point source pollution problems.

An increasing solid waste problem is the disposal of construction debris. Ten to 20 illegal open dumps now exist on the island, with most on the north end.

CHAPTER III-M

COMMUNITY FACILITIES AND SERVICES

This chapter describes publicly financed facilities and services available on Hilton Head Island. Providers of services and facilities include county, state, and federal governments as well as public service districts. Only those providers who maintain an office on the island are discussed in detail.

The County seat is the City of Beaufort, located approximately 35 miles by road from the island. Figure III-M-1 shows the major functions of Beaufort County government. Relative to a population of approximately 63,000 residents, Beaufort County offers a wide range of services. Table III-M-1 lists these services and compares them to other South Carolina counties.

Seven public service districts function on the island. The Medical District covers the entire island; the Fire District boundaries are shown in Plate III-M-1; the other PSD's are shown in Plate III-M-2. The Districts are served by an umbrella organization, the Public Service Council, which is a coordinating body. The powers, jurisdiction, and millage rates for each district are summarized in Table III-M-2. Basically these PSD's offer water and sewer services and have not offered any other services despite various authorizations to do so. The one exception is the Sea Pines/Forest Beach Joint Fire Department.

ORGANIZATION OF BEAUFORT COUNTY GOVERNMENT

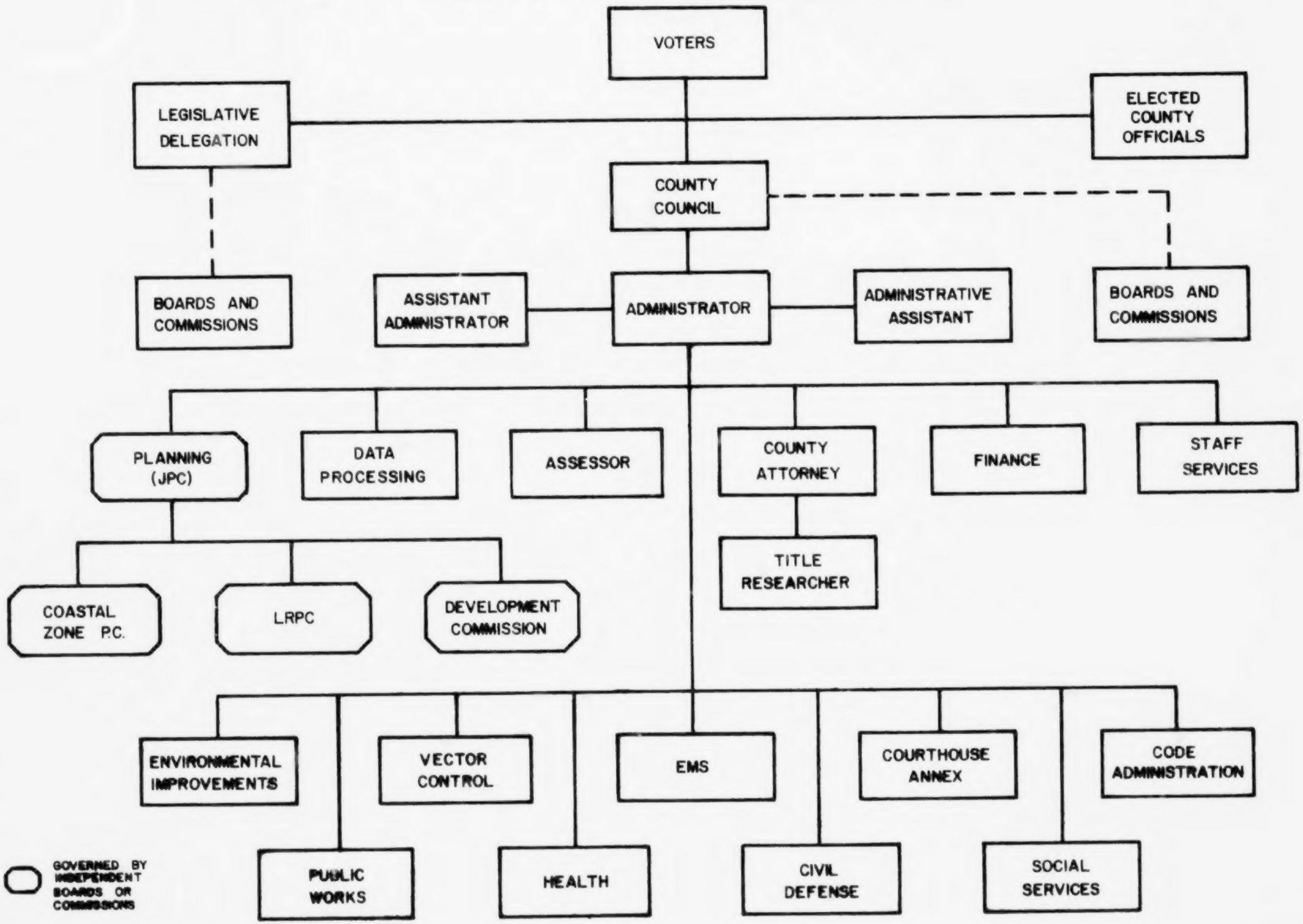

VOTERS
LEGISLATIVE DELEGATION
ELECTED COUNTY OFFICIALS
COUNTY COUNCIL
BOARDS AND COMMISSIONS
ASSISTANT ADMINISTRATOR
ADMINISTRATOR
ADMINISTRATIVE ASSISTANT
BOARDS AND COMMISSIONS
PLANNING (JPC)
DATA PROCESSING
ASSESSOR
COUNTY ATTORNEY
FINANCE
STAFF SERVICES
TITLE RESEARCHER
COASTAL ZONE P.C.
LRPC
DEVELOPMENT COMMISSION
ENVIRONMENTAL IMPROVEMENTS
VECTOR CONTROL
EMS
COURTHOUSE ANNEX
CODE ADMINISTRATION
PUBLIC WORKS
HEALTH
CIVIL DEFENSE
SOCIAL SERVICES
GOVERNED BY INDEPENDENT BOARDS OR COMMISSIONS

FIGURE III-M-1a

TABLE III-M-1

County Functions and Services of Selected South Carolina Counties, Including Beaufort and Jasper Counties

	Beaufort	Jasper	Berkeley	Florence	Greenwood	Sumter
FINANCE						
Property Tax Assessment	x	x	x	x	x	x
Property Tax Collection	x	x	x	x	x	x
POLICE PROTECTION AND CORRECTIONS						
Patrol	x	x	x	x	x	x
Detective Investigation	x	x		x	x	x
Forensic Investigation	x	x	x	x	x	x
Criminal Records	x	x	x	x	x	x
Central Emergency Number				x	x	
Detention Facilities	x	x	x	x	x	x
Work Release Program				x		x
Adult Probation Program	x			x		x
Juvenile Probation Program	x			x		x
JUDICIAL						
General Jurisdiction	x		x	x	x	x
Limited (special) Jurisdiction	x	x		x	x	x
Juvenile/Family Court	x		x	x	x	x
LEGAL SERVICES						
Criminal Prosecution	x		x	x	x	x
Legal/Services	x		x	x	x	x
Indigent Defense	x	x		x	x	x
OTHER PUBLIC SAFETY						
Fire Protection	x	x		x	x	x
Emergency Medical Services	x	x		x	x	x
Disaster Preparedness Programs	x	x	x	x	x	x

TABLE III-M-1 (Continued)

	Beaufort	Jasper	Berkeley	Florence	Greenwood	Sumter
PUBLIC HEALTH						
Mental Health	x	x	x	x	x	x
Mental Retardation Facilities	x			x		x
Alcoholism/Drug Programs	x		x	x	x	x
Animal Control	x	x	x	x	x	x
Sanitation Inspection	x			x		x
Hospital Care	x	x			x	x
Outpatient Medical Services	x				x	x
Homes for the Aged						x
SOCIAL SERVICES						
Income Maintenance	x					x
Emergency Financial Assistance	x			x		x
Food Stamps	x			x		x
Coordinated Services to the Aging	x			x		x
Day Care Services	x					x
MANPOWER						
Job Training	x			x		
Work Experience Programs	x			x		
Public Service Employment	x	x			x	x
TRANSPORTATION						
Road Maintenance	x		x	x	x	x
Road Construction	x		x		x	x
Public Parking Facilities				x		x
Mass Transit	x	x				x
Airports	x		x	x	x	x
Bikeways						x
UTILITIES						
Water Supply	x(special areas only)					
Sewage Treatment	x(special areas only)				x	

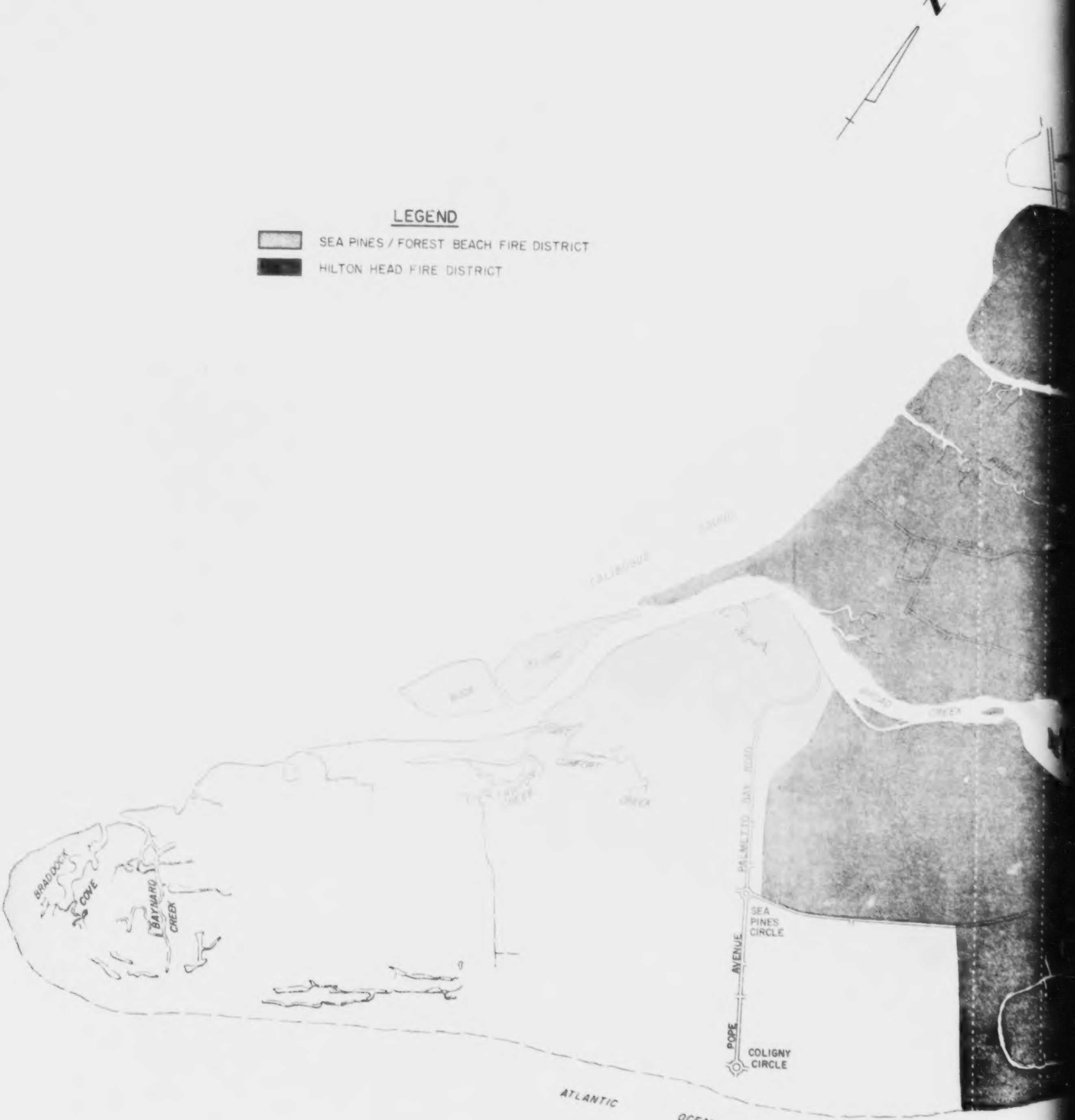
TABLE III-M-1 (Continued)

	Beaufort	Jasper	Berkeley	Florence	Greenwood	Sumter
NATURAL RESOURCES						
Flood/Drainage Control	x			x		x
Coastal Zoning	x	x				
Solid Waste Collection	x	x	x	x	x	x
Solid Waste Disposal	x	x	x	x	x	x
LAND USE						
Comprehensive Land Use Planning	x	x		x		x
Zoning Control					x	x
Subdivision Control	x			x	x	x
COMMUNITY DEVELOPMENT						
Building Code Enforcement	x				x	
Housing Code Enforcement					x	
Conventional Public Housing						x
Industrial Development	x	x		x		x
PARKS						
Park Development	x	x		x	x	
Park Maintenance	x	x		x	x	
County Park	x	x		x	x	
CULTURE AND RECREATION						
Recreational Services	x	x		x	x	
Fairgrounds				x	x	
Swimming Pools					x	x
Museums				x	x	
EDUCATION						
Elementary and Secondary	x	x	x	x	x	x
Community College	x					
Vocational Technical Education	x	x	x	x	x	x

TABLE III-M-1 (Continued)

	Beaufort	Jasper	Berkeley	Florence	Greenwood	Sumter
MISCELLANEOUS						
Land Records	x	x	x	x	x	x
Vital Statistics	x	x	x	x	x	x
Elections	x	x	x	x	x	x
Libraries	x	x	x	x	x	x
Public Information Services						x
Cable Television	x				x	

Source: Report to the Grand Jury of Beaufort County, South Carolina, December 13, 1977 by the County Administrator, pp. 26-28 and The County Yearbook 1977.


N
LEGEND
SEA PINES / FOREST BEACH FIRE DISTRICT
HILTON HEAD FIRE DISTRICT
CALIBOGUE SOUND
BROAD CREEK
PALMETTO BAY ROAD
SEA PINES CIRCLE
POPE AVENUE
COLIGNY CIRCLE
ATLANTIC OCEAN
BRADDOCK COVE
BAYNARD CREEK
CREEK

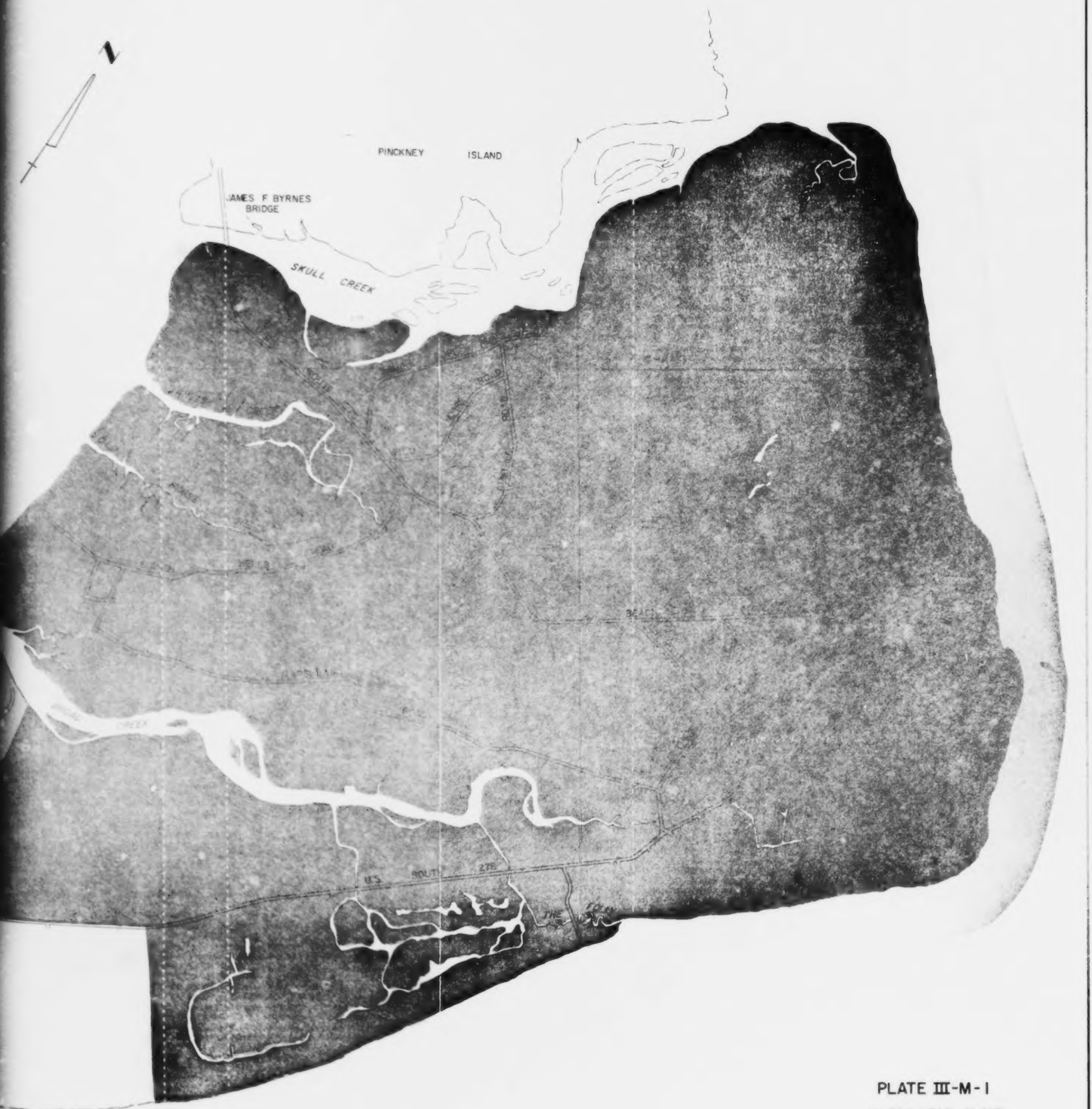

N
PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
BROAD CREEK
U.S. ROUTE 278
THE

PLATE III-M-1

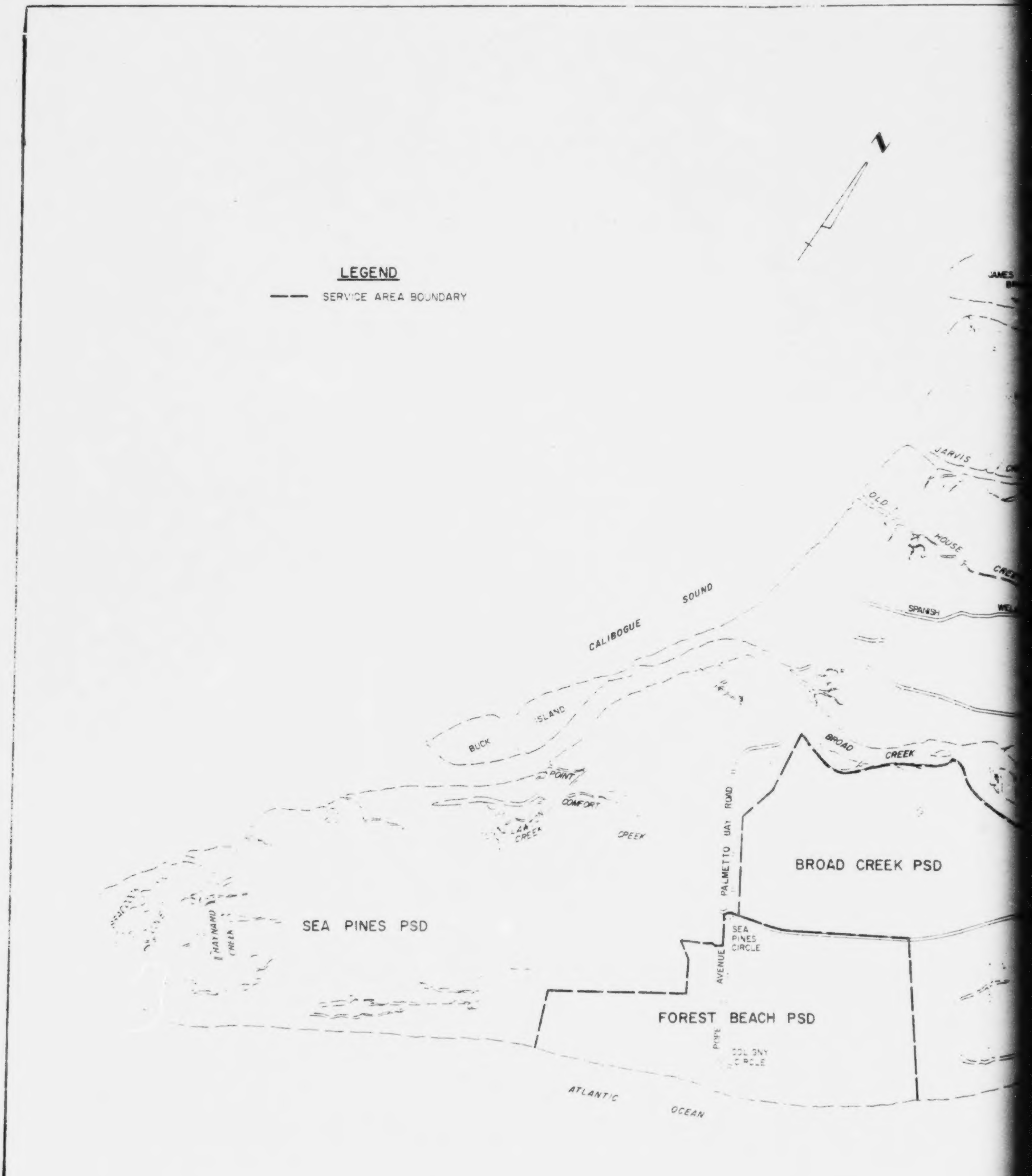
HILTON HEAD ISLAND
SOUTH CAROLINA

FIRE DISTRICTS

3000 0 3000 6000
SCALE IN FEET

US ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

III-M-5-D


N
LEGEND
SERVICE AREA BOUNDARY
JAMES
JARVIS
OLD HOUSE CREEK
SPANISH
CALIBOGUE SOUND
BUCK ISLAND
BROAD CREEK
POINT COMFORT
CREEK
LAWTON CREEK
PALMETTO BAY ROAD
BROAD CREEK PSD
SEA PINES PSD
HAYNARD CREEK
SEA PINES CIRCLE
AVENUE
POPE
FOREST BEACH PSD
COLIGNY CIRCLE
ATLANTIC OCEAN

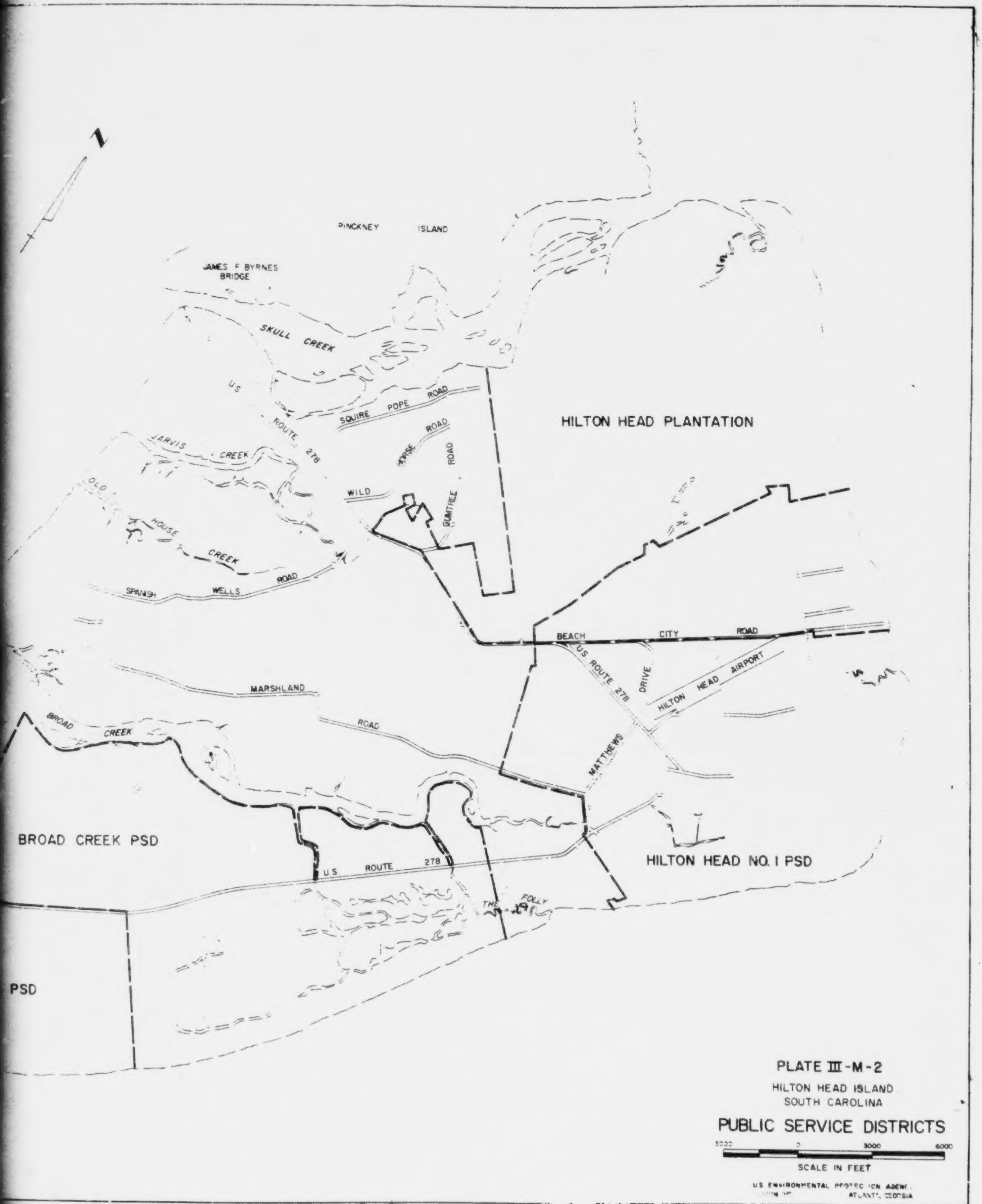

N
PINCKNEY ISLAND
JAMES F BYRNES BRIDGE
SKULL CREEK
US ROUTE 278
SQUIRE POPE ROAD
HILTON HEAD PLANTATION
JARVIS CREEK
WILD HORSE ROAD
GUMTREE ROAD
OLD HOUSE CREEK
SPANISH WELLS ROAD
BEACH CITY ROAD
US ROUTE 278
DRIVE
HILTON HEAD AIRPORT
MARSHLAND ROAD
BROAD CREEK
MATTHEWS
BROAD CREEK PSD
HILTON HEAD NO. 1 PSD
U.S. ROUTE 278
THE FOLLY
PSD

PLATE III-M-2

HILTON HEAD ISLAND
SOUTH CAROLINA

PUBLIC SERVICE DISTRICTS

3000
0
3000
6000
SCALE IN FEET

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IV ATLANTA, GEORGIA

III-M-3-d

TABLE III-M-2

Public Service District and Public Service Council Organization and Powers

	Commissioners	Powers	Areas Served	Tax Levy (1977)
Public Service Council (1973)	Emerson Mulford, Chmn. Charles M. Ackley J. William Cole Gordon F. Craighead, Jr. Henry Driessen Walter Goodrich Zack VanLandingham Robert F. Whitney Isaac Wilborn Eugene Wiley	To provide liaison and coordination between the various agencies of Beaufort County government and Island public service districts	Entire Island	None authorized
Forest Beach PSD (1961)	J. W. Cole, Chmn. Ed Crosby Robert Malphrus Johnnie K. Neidlinger Boyce Ron Staton (T. Kent Langley, Mgr.)	Water, sewer, fire protection, beach erosion and security	North and South Forest Beach, Shipyard Plantation	35 mills*
Sea Pines PSD (1964)	Emerson Mulford, Chmn. Philip A. Bachelder Lyman Kox William J. Kyle, Jr. Robert H. Stafford (R. Arnold Ellison, Mgr.) (David A. MacLellan, Chief, Sea Pines-Forest Beach Fire Department	Water, sewer, fire protection, bicycle paths	Sea Pines Plantation, Bay Pines, Point Comfort, Bay Road, south side of Pope Avenue	33 mills*

TABLE III-M-2 (Continued)

	Commissioners	Powers	Areas Served	Tax Levy (1977)
Hilton Head PSD No. 1 (1969)	Charles M. Ackley, Chmn. Raymond G. Bennett Melville Coburn John Hinchliffe C. J. Jones (Joe Y. Pitts, Jr., Mgr.)	Water, sewer, improvements relative to fire protection (e.g. installation of fire hydrants)	Port Royal Plantation, Grasslawn, Gardner, Hilton Head Terrace, Spanish Oaks Villas, Bridgetown Apartments	44 mills
Hilton Head Public Medical Clinic District (1970)	Lynden J. Kaufmann, Chmn. J. M. Capin Henry Driessen R. F. Whitney Ben Williams	Operation of the Medical Clinic, Pope Avenue	Entire Island	2 mills
Hilton Head Fire District (1971)	John Brown, Chmn. Morris Campbell William Hunter Benny Jones Lynn Smith (Lawrence J. Gooding, Fire Chief)	Fire protection	All areas of the Island outside Sea Pines and Forest Beach	15 mills
Broad Creek PSD*** (1973)	Zack VanLandingham, Chmn. John E. Barbier Jack L. Clapsaddle Carl Lind Charles Shaussermann (William T. Hunter, Mgr.)	Water, sewer, security, fire & "other hazards," roads, walkways, bicycle paths, beach and lagoon maintenance, trails, recreational facilities	Palmetto Dunes, Long Cove Plantation	5 mills

TABLE III-M-2 (Continued)

	Commissioners	Powers	Areas Served	Tax Levy (1977)
Hilton Head Plantation (1973) (not operational)	--	Water, sewer, fire and "other hazards," insect control, erosion, garbage disposal, security, street and road maintenance, bicycle paths, parks and playgrounds, conservation	Hilton Head Plantation	--**

*Includes 30-mill levy for Sea Pines-Forest Beach Fire Department and 5 extra mills in the case of Forest Beach PSD for fire bonds.

**The district does have authority, once operational, to levy a maximum of 15 mills.

***Originally, Palmetto Dunes was served by its own district, the Palmetto Dunes Public Service District, created in 1972. When the Hilton Head Company decided to develop Long Cove Plantation, the act establishing Palmetto Dunes PSD was amended to include that development. The new district was designated "Broad Creek Public Service District." See Act 1739, Acts and Joint Resolutions, 1972, pp. 3405-3423, as amended, House Bill No. 2201 (1973).

Source: Hilton Head Island Government: Analysis and Alternatives II. May, 1978.

Other utilities are furnished by private and semi-private service agencies. Palmetto Electric Cooperative provides electric power throughout the island. Hilton Head Water Company provides potable water to Spanish Wells Plantation, Blue Heron Point, and Mariners Cove. Pargas, Inc. serves subscribers mainly in the northern portion of the island with propane gas. Hargray Telephone Company has island wide services. Plantation Cablevision serves a major portion of the island.

Police and fire protection, schools, libraries, health and medical care, and welfare services are discussed in this chapter. Parks and recreation, refuse collection, transportation, and water and sewer services are discussed in other sections of this report. A more detailed description of community facilities and services can be found in the report, Hilton Head Island Government: Analysis and Alternatives II.

POLICE PROTECTION

The South Carolina Highway Patrol has recently raised manpower assigned to Beaufort County from nine to fourteen patrolmen. Five officers are on duty south of the Broad River. The increase was justified by the county's traffic fatality increase in 1979, 30 deaths by December 19.

The Beaufort County Sheriff's Department maintains a substation on Highway 278 across from Fairfield Square and the Courthouse Annex. Six deputies and a supervising deputy are assigned to the area covered by lower Beaufort County. The island is served by three deputies in the daytime, four in the evening, and three on the midnight shift. Recently, the sheriff has requested funds to support a centrally located precinct station manned 24 hours per day.

Although the City of Beaufort area leads the county in crime, the crime rate is rising on Hilton Head Island and accounts for approximately 31.5 percent of all cases in the county. The crime rate is seasonal and peaks in July and August.

Each plantation maintains a private security force which is paid for by the developer or property owners' association fees. The Broad Creek PSD is empowered to provide security services but instead leaves this to the Palmetto Dunes Resort developers. The Sheriff's Department and state law enforcement agencies have jurisdiction within the private communities but do not routinely patrol the areas due to the deployment of private security forces.

A survey conducted as part of the Hilton Head Island Government study reported that law enforcement was a major community concern. Respondents are concerned that the Sheriff's Department does not patrol the public beaches and that islanders are dependent upon State Highway Patrol officers to investigate traffic accidents. Increasing rates of robbery and burglary are a problem in public areas as well as private communities. Law enforcement agencies have also been criticized for placing inadequate emphasis on crime prevention. The survey concludes that current levels of dissatisfaction with police protection can be expected to increase unless services keep pace with population growth on the island.

Crime and traffic law enforcement have continued to be active community issues. In December, 1979, the Hilton Head NAACP, the Hilton

Head Community Association, and the Hilton Head Women's Club convened representatives of law enforcement agencies and private security companies in a fact-finding meeting. Public hearings will be scheduled at a later date.

FIRE PROTECTION

The Hilton Head Fire District covers approximately two-thirds of the island, that area outside the Sea Pines and Forest Beach PSD's (see Plate III-M-1). The department consists of a professional chief, six paid firefighters, and 15 volunteer firefighters in reserve. Fire department personnel are also qualified EMS technicians.

The main station is located on Matthews Drive, and the second station is located in the Spanish Wells area. Plans have been made for two other stations, one at Hilton Head Plantation and the other at Palmetto Dunes Resort. Each is to be financed by the developers.

The department is equipped with four pumpers and a 6000-gallon tank truck. An EMS ambulance is maintained at the Matthews Drive station. By 1980, the department hopes to have purchased two more pumpers and a ladder truck. Fire hydrants are installed only in the more densely developed areas; the department relies otherwise on the 6000-gallon pumper truck.

Fire ratings are established by the National Board of Fire Underwriters and are used by the insurance industry to establish fire insurance premiums. Ratings are based on an evaluation of water supply; service district sizes; manpower and firefighting equipment; laws and ordinances covering the manufacture, storage, and use of hazardous materials for building construction; and communications equipment and its use. The district's current rating is 9 on a scale of 10, where 1 is highest and represents the best quality service. Consequently, premiums are high in the district, since the rating is low.

The Sea Pines and Forest Beach PSD's have financed and administer a joint fire department. Policy is set by a joint subcommittee of the PSD's. The fire department operates out of two fire stations: one just inside the gates of Shipyard Plantation and the other on Lighthouse Road inside Sea Pines Plantation. The department presently employs 36 paid personnel: a fire chief, an assistant chief, 27 firefighters, two fire prevention officers (fire inspectors), four dispatchers, and a secretary. Volunteer firemen are on call to assist as needed. The department is equipped with a 75-foot aerial truck, 4 pumpers, and several pieces of auxiliary equipment. Several fire department personnel are volunteer trained EMS technicians.

The dispatchers are on duty 24 hours a day. They answer the 911 emergency telephone number and dispatch all emergency services for areas in Beaufort County south of the Broad River including the Sheriff's Department, South Carolina Highway Patrol, the two fire departments, and the Island Rescue Squad. In recent years, each agency has paid its prorata share of the costs of the dispatch service. The responsibility for covering the Island Rescue Squad's costs is now a matter of discussion between the Squad, Beaufort County, and the PSD.

Due to the Sea Pines/Forest Beach Department's good ratings for staffing, equipment, and communications systems plus the installation of fire hydrants throughout the service area, property owners in these two PSD's have recently received premium reductions when the fire insurance rating was changed from 9 to 5.

SCHOOLS AND LIBRARIES

The Hilton Head Elementary School was originally housed in what is now the Courthouse Annex. A new school was built in 1974 and serves grades K-6. Enrollment has steadily dropped from 644 students in 1977-78 to 602 students in 1978-79 to 559 students in 1979-80. McCracken High School on the mainland at Bluffton, enrolls grades 7 - 12. Courses are offered in four areas: academic, business, vocational, and general studies. Attendance has declined from 762 students in 1977-78 to 740 in 1978-79 to 703 in 1979-80. These losses have occurred at a time when the island's population is increasing and reflects a widespread dissatisfaction with the quality of education in Beaufort County.

Three private schools are located on the island. Sea Pines Montessori School and Montessori Gardens offer preschool and first grade classes, while Sea Pines Academy goes through twelfth grade. Enrollments have risen in recent years, and each is nearing capacity with regard to present facilities.

Recently the Beaufort County Board of Education reached the decision to issue bonds in the amount of $16.25 million for construction of new schools and upgrading facilities. A new high school is planned for lower Beaufort County, possibly on the island. The estimated cost is $6.25 million. McCracken High School may then become a middle school.

One public library exists on Hilton Head. It is a branch of the Beaufort County Library which was opened in 1976 on Highway 278 near Port Royal Plantation. It contains approximately 10,000 volumes. The facility was constructed with $265,000 in federal revenue sharing funds.

HEALTH AND MEDICAL CARE

Health and medical care is provided by an assortment of public and private agencies. The Beaufort-Jasper Comprehensive Health Services, Inc. (BCJH), a federally-funded agency, has over 25,000 registered outpatients and provides medical service to the two-county area on a sliding-fee-scale basis in addition to continuing to serve the indigent.

The County Health Department serves the island from offices in the Courthouse Annex. Its services include food inspection in commercial establishments and inspection of septic tanks. Health clinics at the Annex offer a variety of programs and services. A Child Health Clinic performs well baby checkups and refers any problems to the Pediatric Clinic. A Family Planning Clinic and a Supplemental Food Program for Women, Infants, and Children (WIC), have been established.

The Hilton Head Medical Clinic District operates the clinic facility located on Pope Avenue and the adjoining training facility for island and county EMS staff. Policy is set by a commission whose members are appointed by County Council. Historically, two mills of the property tax levy have supported the Clinic's operations.

The clinic is leased by a professional association which has a staff of two full-time doctors, two part-time doctors, one dentist, and a dental technician/hygienist. The association pays the district five percent of its gross income, which goes for rent, replacement of equipment, and part of the maintenance costs for the building. Over the last five years, the district commission has managed to accumulate a surplus of approximately $75,000. Because of this, the commission has reduced the district's tax levy from two mills to no mills. This reduction is for 1979 only.

The clinic presently serves about 800 outpatients. Prior to establishment of the Hilton Head Hospital, the clinic served twice this number.

The Island Rescue Squad was started originally by Medical Clinic physicians before the Beaufort County EMS program was developed. Currently, the unit is supported by County funds, private donations, and a $1.00 per year lease from the Medical Clinic for use of the training center/headquarters and two ambulances. However, the State Attorney General has rendered an opinion that a public agency such as the Medical

Clinic cannot support a private non-profit organization such as the Island Rescue Squad. The Board of the Medical Clinic is presently appealing the decision. Should the appeal fail, the rent for the building will be raised to $800.00 per month, which the Island Rescue Squad cannot afford. New quarters will have to be found or the Squad may have to cease operations.

Since establishment of the Hilton Head Hospital in 1975, fewer islanders have traveled to Beaufort County Memorial Hospital and the Savannah hospitals for care, although they still serve the island community. The Hilton Head Hospital contains 80 beds, 40 of which are in use at this time. Professional staff specialties include:

- Anesthesiology
- Cardiology
- Clinical Psychology
- Cytology
- Dentistry
- Dermatology
- Endoscopy
- Family Practice
- General Surgery
- Internal Medicine
- Neurosurgery
- Obstetrics & gynecology
- Opthamology
- Orthopedic Surgery
- Pathology
- Pediatrics
- Plastic & Reconstructive Surgery
- Psychiatry
- Radiology
- Urology

A number of physicians maintain offices at the LaMotte Professional Building next door to the hospital.

The hospital is a private, non-profit, fully certified medical facility administered by a Board of Trustees. It offers a full range of services including a 24-hour emergency room. Although it is a private hospital, indigent patients are also treated. The hospital participates in Blue Cross/Blue Shield, Champus, Medicare and Medicaid programs, and commercial insurance programs. It receives $10,000 per year from the United Way and benefits from the fund raising activities of an active volunteer auxiliary.

Hospital construction was privately financed by the sale of bonds just prior to the recession of 1974. Development on the Island came to a near standstill in the mid-1970's, and the projected volume of patients did not materialize. When the hospital faced default on payment of its debt in 1977, the hospital board requested that the County Council appropriate funds for this purpose. County Council responded by levying additional millage (4 mills for FY 1978 and 2.5 mills for FY 1979) to raise revenue for a reserve fund, on condition that interest payments on the $11.2 million in hospital bonds be voluntarily and temporarily suspended. Recently, the courts have ruled that Beaufort County may not levy taxes to support a private institution, and the hospital reserve fund has been transferred to the Board of Education. The hospital's financial problems are expected to be temporary, and current revenues are covering expenses.

The Island Government survey reports that residents believe their medical care is second to none and are very well satisfied with current services.

WELFARE AND SOCIAL SERVICES

The offices of a number of county, state, and federal social services agencies are located at the Courthouse Annex. Some offices are staffed five days a week, others only one or two days a week. A toll-free number has been established from the island to County government offices in Beaufort in order to increase accessibility of services.

The Annex provides office and meeting space for Family Court, the Department of Social Services, Probate Court, Job Service (S.C. Employment Service), the Alcohol and Drug Abuse Commission, Clemson University Extension Service, the County Health Department, Building Inspection, Social Security, the State Tax Commission, State Highway Department, State Highway Engineer, Community Development, S. C. Probation and Parole, Recreation Commission, Beaufort-Jasper Rural Transportation Authority, Beaufort County Council (as needed), Voter Registration, Mobile Home Licenses, and other county officials visiting or doing business on the island. Public meeting rooms are also available at the Annex on request.

SUMMARY

Fire protection, libraries, and health care are generally considered fully satisfactory by the island residents. Public education and police protection are thought to be deficient according to residents surveyed.

Most residents are concerned about the ability of local government services, provided by both county agencies and PSD's, to keep pace with the rapid growth which is anticipated in the future. This concern provided the impetus for the study funded by the Hilton Head Community Association of alternative forms of local government. The basic study, undertaken in 1974, was updated in 1978. The Community Association continues to assess the evolving needs of the island for community services and facilities and has taken the lead in making Beaufort County officials aware of service deficiencies.

CHAPTER III-N

TAXES AND FINANCING OF PUBLIC SERVICES

Beaufort County government is quite sound financially, although subject to the same inflationary pressures and demands for increased services that are affecting local governments nationwide (Fleming, 1978). Prosperity may be measured by the County's tax base, which continued to grow at an average annual rate of over 18 percent between 1968 and 1978. Much of this growth is attributable to development on Hilton Head Island.

This chapter will discuss sources of revenue for Beaufort County and will indicate what portions are derived from Hilton Head. In addition, County expenditures for services and facilities will be discussed.

REVENUES

Beaufort County collects revenues for its own operations, the Board of Education, and the special service districts. The following discussion focuses on an analysis of revenues collected for the County's general operations.

Table III-N-1 shows the sources of revenue in Beaufort County and compares the percentage each source represents to average percentages for cities and counties nationwide. Beaufort County's reliance on property taxes is apparent.

Table III-N-2 presents a more detailed breakdown of the information shown in Table III-N-1. Table III-N-2 shows that reliance on the property tax as a percent of revenue is virtually unchanged since 1968, although the dollar amount has increased nearly tenfold. State-shared revenues as a percent of county income has decreased threefold, although again the dollar amount has increased significantly. Federal grants have risen dramatically both as a source of income and as a percent of revenues received.

Further analysis of the County's reliance on the property tax (real estate and real property) is provided. Table III-N-3 shows total assessed values, millage rates, and property tax revenues for the past seven years. Value is assessed at four percent of fair market value for property owners who reside in the county more than six months per year. Other property owners are assessed at six percent of fair market value.

Assessed values and revenues have risen steadily. The major increase in assessed values shown in 1978 reflects the results of a countywide revaluation program. Millage rates in 1978 were reduced sharply from 160 to 107 mills in compliance with a State law, Act 208, which mandates that the tax yield after a revaluation must fall within one percent of what it would have been under the previous assessed value and millage levy.

For several years assessed values on Hilton Head Island have represented over 50 percent of the County's tax digest. A subject of

TABLE III-N-1

SOURCES OF CITY AND COUNTY REVENUES FOR GENERAL OPERATIONS AND PERCENTAGE OF TOTAL REVENUES COLLECTED FROM EACH SOURCE

Source	Cities (Average)	Counties (Average)	Beaufort County (Actual)
Property Tax	35.9	29.8	45.2
Federal Aid	13.1	8.5	18.2
State Aid	6.1	14.2	10.7
Fees and Licenses	13.4	4.4	8.2
Borrowing	3.1	1.9	1.4
Miscellaneous (fines, public works and services, etc.)	28.4	41.2	16.3
Total:	100.0	100.0	100.0

Source: Local Government Finance in South Carolina, 1978-1980, pp. 62-129 and Beaufort County audit, 1977, and proposed budget, 1978.

TABLE III-N-2

SUMMARY OF REVENUES FOR GENERAL OPERATIONS OF BEAUFORT COUNTY FOR SELECTED YEARS*

Revenue Source	1968	Percent of Total	1973	Percent of Total	1978	Percent of Total
Property Taxes	$383,535	45.28	$ 807,355	41.82	$3,110,750	45.18
State Shared Revenues	261,052	30.82	619,601	32.10	734,951	10.66
Licenses & Permits	5,213	0.62	5,020	0.26	178,000	2.59
Fines	75,531	8.92	118,240	6.13	188,500	2.74
Fees	47,395	5.59	220,313	11.41	386,600	5.62
Sale of Property and Services	5,777	0.68	25,556	1.32	312,467	4.54
Other Revenues	4,893	0.58	19,760	1.02	50,000	0.72
Earmarked Revenue	63,706	7.51	100,234	5.19	333,964	4.85
Federal Grants	-0-	-0-	14,275	0.75	1,251,975	18.18
Carry Forward					337,337	4.89
Total	$847,102	100.00	$1,930,354	100.00	$6,884,544	100.00
In 1968 Dollars	$847,102		$1,533,280		$3,526,000	

*Adjusted for interfund transfers of monies between the General Fund and Library Fund.

Source: Report to the Grand Jury of Beaufort County, South Carolina, December 13, 1977 by the county administrator.

TABLE III-N-3

BEAUFORT COUNTY ASSESSED VALUES, BASIC COUNTY TAX LEVY AND REVENUE YIELD, 1973-1979

Calendar Year	Assessed Value*	Basic County Levy (in mills)	Revenue Yield
1973	$33,350,422	102	$3,401,743
1974	38,882,260	109	4,238,166
1975	43,840,726	121	5,304,728
1976	50,396,364	142	7,156,284
1977	54,308,515	160	8,689,362
1978	86,027,371	107	9,204,929
1979 (est.)	$89,447,085	110	$9,839,179

*This is total taxable property, which includes real property and personal property.

Source: Information provided by Beaufort County Treasurer.

debate among islanders is whether or not services received from the County are proportional to revenues derived from the area. The quality of several important public facilities and services has been criticized by island residents, as discussed in other chapters of this report.

Table III-N-4 compares assessed values and property tax revenues generated on Hilton Head Island before and after the revaluation program. The increases in assessed values and revenues is a reflection of both inflation and the continued build out of the island subsequent to the recession of the mid-1970's.

When comparing the percent average annual increases in revenue yields between 1976 and 1978, the greatest increases are seen in the northern portion of the island. These increases reflect an accelerated pace of development at Palmetto Dunes Resort, Port Royal Plantation, Hilton Head Plantation, and commercial facilities along Highway 278. The same figures for 1979 reflect a more modest growth rate for all areas of the island except Hilton Head Plantation, which is one of the least developed areas and has experienced significant growth in 1979.

The total County tax burden for residents of Hilton Head Island is composed of the basic countywide levy (110 mills in 1979) plus additional levies for services provided only on the island. Table III-N-5 shows the breakdown of the basic countywide levy and Table III-N-6 shows Island District levies.

TABLE III-N-4

ASSESSED VALUES ON HILTON HEAD ISLAND
SELECTED RECENT YEARS

		1976			1978				1979			
Dist.	District Name	Assessed Value	Pct. of Tot. Cnty. Ass. Val.	Yield at 142 Mills	Assessed Value	Pct. of Tot. Cnty. Ass. Val.	Yield at 107 Mills	Pct. Avg. Annual Yield Incr.	Assessed Value	Pct. of Tot. Cnty. Ass. Val.	Yield at 110 Mills	Pct. Avg. Annual Yield Incr.
050	Hilton Head	$ 1,721,100	3.4	$ 244,396	$ 3,122,450	3.6	$ 334,102	18.5	$ 3,201,246	3.6	$ 352,137	5.4
051	H. H. PSD#1	2,699,980	5.4	383,397	5,148,650	6.0	550,906	22.0	5,339,274	6.0	587,320	6.6
052	Broad Creek PSD	3,177,096	6.3	451,148	5,911,441	6.9	632,524	20.0	6,350,594	7.1	698,565	10.4
053	Hilton Head Plantation	776,900	1.5	109,897	1,578,121	1.8	168,859	27.0	2,362,372	2.6	259,861	53.9
060	Forest Beach PSD	5,497,370	10.9	780,627	8,754,961	10.2	936,781	10.0	9,025,160	10.1	992,768	6.0
070	Sea Pines PSD	13,953,063	27.7	1,981,335	21,319,986	24.8	2,281,239	7.5	22,338,572	25.0	2,457,243	7.7
	Island Totals	$27,822,509	55.2	$3,950,797	$45,835,609	53.3	$4,904,411	12.7	$48,617,218	54.4	$5,347,894	9.0
	Countywide Totals	$50,396,364	100.0		$86,027,371	100.0			$89,447,085	100.0		

Source: Beaufort County Treasurer's Office, 1979

TABLE III-N-5

COUNTYWIDE LEVY, 1979

Category	Mills
Recreation	3.4
Hospitalization Costs for Indigents	1.5
Beaufort Tech. Education College Center	0.6
General County Operations	36.0
County Bonds	5.0
Schools Maintenance and Operations	58.3
School Bonds	5.2
	110.0

Source: Beaufort County Treasurer's Office, 1979.

TABLE III-N-6

DISTRICT LEVIES, 1979 (in Mills)

District	District Name	Public Service District		Fire District	Beaufort County	Total
		O&M	Bonds			
050	Hilton Head			15.0	110.0	125.0
051	H.H.PSD #1	5.0	21.0	15.0	110.0	151.0
052	Broad Creek PSD	5.0		15.0	110.0	130.0
053	Hilton Head Plantation			15.0	110.0	125.0
060	Forest Beach PSD	3.0	2.5	22.5*	110.0	138.0
070	Sea Pines PSD	2.0		22.5*	110.0	134.5

*Fire services are provided by the joint PSD's fire department, not the Hilton Head Fire District.

Source: Beaufort County Treasurer's Office, 1979.

A significant source of local government revenue is borrowing. In Table III-N-7 direct and overlapping debt as of October 31, 1979 are shown.

Debt as a percent of assessed value is highest for the Forest Beach PSD at approximately 43.2 percent. The Sea Pines and Forest Beach PSD's have recently found it necessary to upgrade and expand their water lines, wastewater treatment system, and fire department. These costs have been shared equally and have had a significant impact on the Forest Beach PSD, whose tax base is approximately 40 percent of Sea Pines.

In 1974 the Hilton Head PSD #1 purchased from the Hilton Head Water Company that portion of the system already serving the district with water. This debt represents nearly half of the district's current debt. Other obligations are associated with the wastewater treatment system. At 151.0 mills, residents of this PSD pay the highest taxes on the island (see Table III-N-6).

A $25.4 million school bond issue proposed in late 1979 by the County Board of Education generated widespread controversy and has subsequently been scaled down to $16.25 million. Under current law, the Board of Education may issue bonds in any amount without the approval of the County government or the voters. Sen. James D. Waddell (D-Beaufort County) has stated he will introduce a bill in the 1980 state legislative session which will make the Board of Education's bonding authority identical to that of the County. Thus, the Board would be limited to issuing

TABLE III-N-7

STATEMENT OF DIRECT AND OVERLAPPING DEBT
BEAUFORT COUNTY, AS OF OCTOBER 31, 1979

District	Outstanding Bonds/Notes	Applicable Assessed 1979 Property Values	Debt as Percent of Assessed Values
Beaufort County	7,077,000	89,447,085	8.0
Board of Education	3,935,000	89,447,085	4.4
Sea Pines PSD	4,300,000	22,338,572	19.3
Treasury Services	(3,080,000)		(13.8)
C&S Col. Treas. Serv.	(1,047,000)		(4.7)
Fire Dept.	(175,000)		(0.8)
Forest Beach PSD	3,903,000	9,025,160	43.2
Sewer & Water	(3,728,000)		(41.3)
Fire Dept.	(175,000)		(1.9)
Broad Creek PSD	0	6,350,594	0.0
H.H.PSD #1	1,095,000	5,339,274	20.5

Source: Beaufort County Treasurer's Office, 1979.

bonds in the total amount of eight percent of the assessed property value of the County (approximately $7.2 million) without a voter referendum.

Due to soaring bond interest rates in March, 1980, the school building program could be held up for a number of months. Options available to the Board of Education include 1) selling bonds at current rates of over 8.0 percent, 2) waiting for the interest rates to drop, or 3) issuing bond anticipation notes on a fraction of the $16.25 million and retiring the bonds at a later date when the remainder of the issue is sold.

Should the Board of Education issue 25-year bonds at current rates, additional millage required could start at about 20 mills in the early years and gradually scale down to around 13 mills (in constant 1979 mills) in later years.

Considering that the Board of Education's current bonded indebtedness is approximately $4.0 million, the new bond issue is a major undertaking and has been subject to intense community debate. Many persons believe that such a large commitment at this time will tie the financial hands of the Board of Education and decrease its ability to respond to future needs. Others fear that future County bonds will be less attractive to investors when the County's full faith and credit is so heavily pledged to the school bonds.

EXPENDITURES

In 1978, total tax revenues were $21,644,001. Table III-N-8 shows major categories of expenditures.

The County Operations category is further broken down in Table III-N-9. Public Works is the largest single category of expense followed by the composite Social Services/Health/Leisure grouping, Public Safety, and composite Personnel-type costs. Over the past decade, the percent allocations have varied slightly but the dollar amounts have increased dramatically.

TABLE III-N-8

MAJOR CATEGORIES OF EXPENDITURES, 1978

Category	Percent
School Operations and Maintenance	63.68
School Bond Debt	1.09
Special Tax Districts	2.40
County Bond Debt	1.81
County Operations	31.02
	100.00

Source: "Look What You're Doing for Beaufort County" Pamphlet sponsored by Beaufort County Council, 1978.

TABLE III-N-9

SUMMARY OF EXPENDITURES, BEAUFORT COUNTY(1)

Category	1968	Percent of Total	1973	Percent of Total	Projected 1978	Percent of Total
Legislative	$ 9,773	1.17	$ 19,608	1.12	$ 255,088	3.71
Employee Benefits	59,072	7.09	129,229	7.39	758,269	11.01
Administrative	25,000	3.02	54,112	3.10	257,104(2)	3.73
Finance	54,446	6.55	145,383	8.32	467,964	6.79
Leisure	67,193	8.08	164,651	9.42	463,009	6.72
Social Services	21,883	2.64	17,328	0.99	256,228	3.72
Health	93,092	11.19	174,809	10.00	567,452	8.24
Public Safety	140,499	16.89	306,500	17.54	1,196,645	17.39
Public Works	238,306	28.64	488,215	27.93	2,065,317	30.00
Planning & Dev.	52,293	6.28	79,481	4.55	180,405	2.63
Judicial	65,976	7.92	159,653	9.13	417,063	6.06
Miscellaneous	4,490	0.53	8,774	0.51	-0-	-0-
Total	$832,023	100.00	$1,747,743	100.00	$6,884,544	100.00
(In 1968 Dollars)	$832,023		$1,388,292		$3,526,890	

(1) Adjusted for interfund transfers of monies between the General Fund and Library Fund.
(2) Contingency accounts were allocated based upon Council action to date and projected wage and benefit allocations of 11.75 percent.

SOURCE: Report to the Grand Jury of Beaufort County, South Carolina, December 13, 1977 by the County Administrator.

SECTION IV

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